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JOURNAL OF ELECTRICITY
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VOLUME XXVII SAN FRANCISCO, JULY 15, 1911 NUMBER 3

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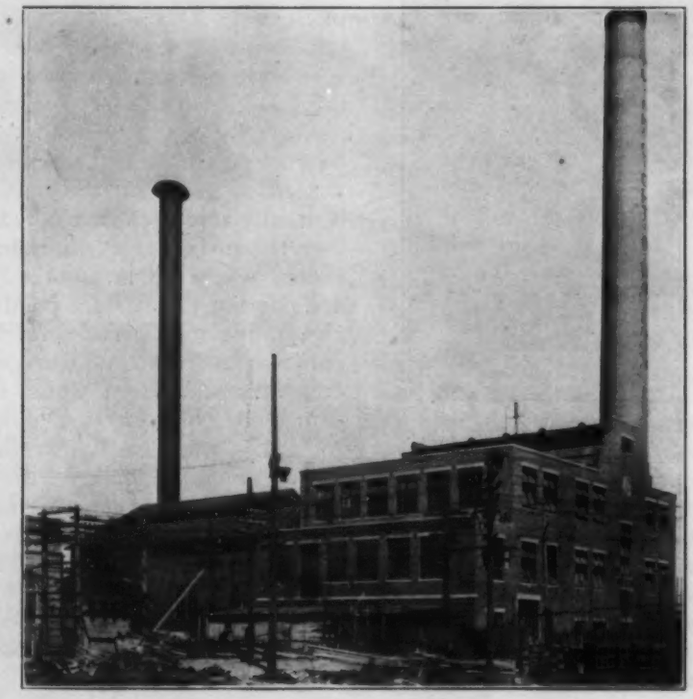
JORDAN STEAM STATION

The Utah Light & Railway Co. supplies practically all of the electric service for Salt Lake City, Utah, and during its growth has absorbed a large proportion of the output of the hydroelectric power generating and transmission companies which utilize water powers in the mountain region surrounding Salt Lake City. The increase of the business and the somewhat restricted possibilities of the available water powers have led the management of this company to provide a steam driven power station, primarily for the purpose of acting as a relay to the various hydroelectric transmission systems, and in order to form a nucleus of such further steam generating equipment as the future may require. The presence of coal measures in the Wasatch Mountains within 40 or 50 miles of Salt Lake City by rail led to an investigation to determine the best site for such a plant, and at this stage of the proceedings Westinghouse, Church, Kerr & Co. of New York were retained to act as engineers and report on the situation. In July, 1909, after considering the advisability of producer gas as well as steam, and the location of the plant at the coal mine, as alternatives, they reported in favor of a steam power station to be located (preferably on the Jordan River) adjacent to Salt Lake City. In the spring of 1910 this report was acted on, and the engineers were authorized to act also as constructors, and to proceed with the design and construction of the new power station.



Power House of Utah Light & Railway Company

Among the conditions governing the design of this station were the following:

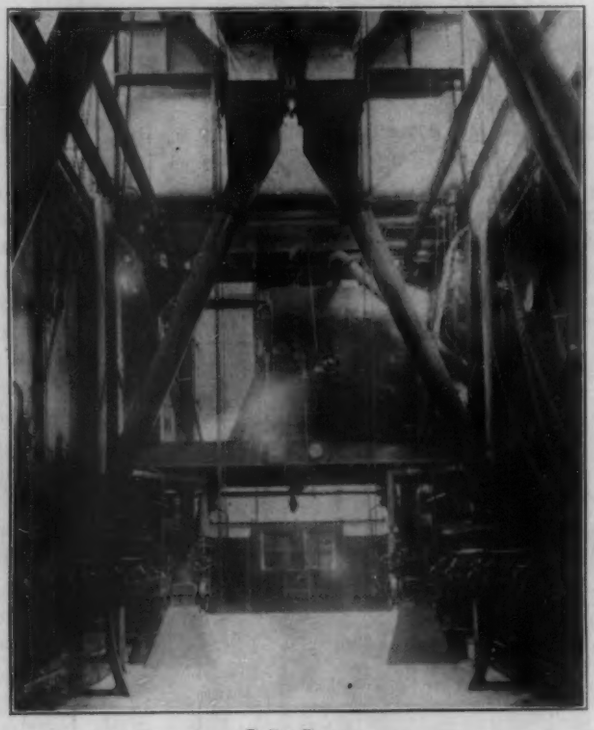
(a) Operation not continuous at first, but as a relay to the system; (b) an ample supply of condensing water, unsuitable, however, for boiler feed; (c) feed water to be purchased at a relatively low cost; (d) coal to be brought from mines already developed in Wyoming carrying about 11,700 B.t.u. per pound; (e) power station site being on property owned by the company and having railroad connection.

The fact that the station is intended to be a relay and not continuously operated, implies a very low load factor which called for the exercise of economy in first cost of construction. Accordingly, the building as well as the contained equipment was to be laid out as to reduce the volume per unit of generating capacity to a very low figure. The cubic contents of the building (which includes ample switchboard room for all the generating equipment it can contain) is 56 cubic feet per kilowatt of maximum continuous output.

This station is designed on the so-called "unit system," a "unit" comprising a self-sufficient combination of boilers, generating units, condensers, and enclosed building, so arranged that it can be uniformly and economically duplicated, and when so duplicated, economically operated either alone or in parallel with

the other sections. As shown in the plan, the boiler room, which is completely filled with six 600 h.p. boilers, is of the same length as the turbine room with its single 10,000 k.v.a. turbo-generator, condenser and auxiliaries. It is evident that future needs for greater capacity of this station can be economically met by adding to it one or more units of equipment and enclosing building of the same size as this first one.

The power station building is of brick, with concrete slab floors and roof. The boiler room includes an overload coal bunker. This portion of the structure is of skeleton steel construction carrying the greater part of the weight on columns. The turbine room requires no steel framing other than that needed for the roof trusses, floor beams and crane rails. While no money was spent to secure architectural effect, the design is well proportioned and dignified in character.



Boiler Room

The foundation of this station rests upon a pile concrete mattress composed of Oregon fir piles 36 ft. long, spaced 2½ to 3 ft. between centers, overlaid with a practically uniform thickness of 3 ft. of concrete. The condenser intake and overflow flumes, where within the building line, are formed in the concrete foundation. The main flumes extend from the river bank just outside of and parallel to the building wall, being so placed that they can readily be extended to accommodate future additions to the station, which will be served as in the present case by branches extending from the main flumes into the power station foundations.

Steam is generated in six 600 h.p. Stirling boilers fitted with the improved Roney stoker operated by natural draft which is supplied by a single stack. The steam pressure is 200 lbs. with 125 degrees superheat. The arrangement of flues and stack was designed to fit in with the general unit system which will involve the building of an additional stack for every six boilers added to the plant. The boilers next the turbine room are provided with a cross flue running just under the coal bunker, for connecting them with the stack. By means of a system of skylights placed just below the level of the coal bunker, the firing alley between boilers is provided with far better daylight illumination than usual.

The load conditions at this plant did not warrant the installation of economizers. The stack is of radial brick, 11½ ft. in diameter and 225 ft. high. Commercial relationship with the management of the mines rendered it unnecessary to make provision for storing coal on a large scale, thus simplifying the problem of transferring the coal from the railroad cars to the stoker hoppers. The cars dump into a track hopper from which coal is carried up by an inclined bucket elevator to the top of the boiler house at one end, where it discharges onto a horizontal belt conveyor by which it is distributed through the bunker over the boilers. The ashes are dumped from the ash pits into side dump cars which run on an industrial railroad in the boiler room basement and are elevated by a platform lift to the ground level, where they are run out to dump their contents as filling for adjacent land.

The main turbo-generating unit is of 10,000 k.v.a. maximum continuous capacity, with a temperature rise of not to exceed 50 degrees C. The machine is of the Westinghouse-Parsons semi-double flow type of 3600 r.p.m., and generates three-phase, 60 cycle current at a potential of 4400 volts.

The condensing apparatus is of the mixing type, the LeBlanc condenser being furnished by the Westinghouse Machine Company. Although it has usually been the practice, where feed water has to be purchased, to use a surface condenser, the LeBlanc type is usually able to show a vacuum of ½ in. to 1 in. better than the surface type, with similar water temperatures except where an unusual expenditure is incurred in maintaining the surface condenser. The greater efficiency due to a greater vacuum, combined with the reduced cost of maintenance, more than offsets the increased cost of feed water that has usually accompanied the older forms of mixing condensers.

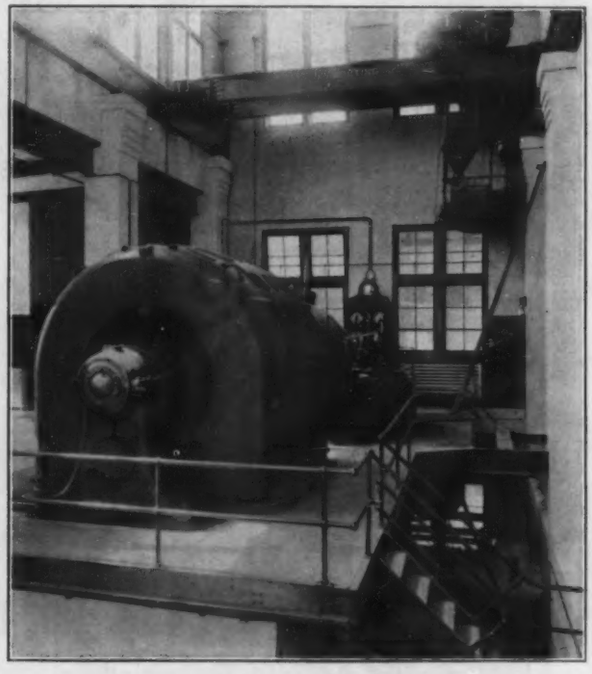
As is the case with other main features of the power house equipment, the piping is of distinctly modern design and construction. Pipe flanges for high pressure steam are welded on, and cast steel fittings and valve bodies are used. The valve seats, discs and spindles are of Monel metal. Particular attention is also given to providing for the expansion and contraction inevitable with high pressure steam and superheat temperatures. The Holly Gravity Return System is used in returning condensation in the main steam connections back to the boilers.

The generators are fitted with the usual ventilating ducts. The exciters are of the Westinghouse turbine driven type of 100 kw. capacity. The boiler feed pumps are steam driven, of the compound duplex pressure pattern. The air and circulating pumps on the LeBlanc condenser are driven by a small steam turbine.

The switchboard apparatus is contained in a cellular structure of the type now so common in high ten-

sion power stations, being in this instance built of solid concrete. The ring type of bus has been adopted as offering the greatest flexibility in switching combinations of generators and feeders, with the least number of switches installed. The oil switches are General Electric type H-3, electrically operated from a bench board of the usual type.

Progress in the construction of this station has been remarkably rapid. Active construction began about August 19, 1910, upon the arrival of the first carload of piles. By the middle of October the piles



Interior View Showing Generator

were all in and the concrete wall enclosing the basement was well along towards completion. By November 10th the building walls were nearly finished and the stack well under way. By the middle of December the exterior of the building was completed, the windows were in and the stack was finished. Steam was raised in the boilers on February 6, 1911, the turbine was turned over for the first time on February 15, and the station was reported ready to permanently carry commercial load on March 22, 1911. The entire work of design and construction was executed by Westinghouse, Church, Kerr & Company, under the direction of the Utah Light & Railway Company officials, Mr. O. A. Honnold, electrical engineer being in charge of the work for them.

EROSION OF SLOPES OF CULEBRA CUT AT PANAMA.

Arrangements have been made to sow various kinds of grass seeds on the slopes of Culebra Cut, with a view to reducing erosion. The seed has arrived and will be planted under the direction of Mr. H. Pittier, a botanist from the Smithsonian Institution.

This method of plant growth on large cuts has proved eminently practical in various American engineering enterprises in the prevention of erosion.

CHARACTERISTICS OF TRANSMISSION LINES

In a paper presented at the Twenty-eighth Annual Convention of the American Institute of Electrical Engineers, held at Chicago, June 26-30, 1911, Harold Pender and H. F. Thomson presented an ingenious series of practical solutions of the mechanical and electrical characteristics of transmission lines.

We publish herewith the charts submitted in this paper and will take illustrations of such a simple nature in the way of their application, we hope they may become of much practical service with minimum effort employed.

Before proceeding further it will be of value to note the assumption made in arriving at the equations from which the charts were plotted. The treatment naturally falls under two headings: A—Mechanical Characteristics; and B—Electric Characteristics.

In arriving at the equations for the mechanical characteristics of transmission lines the discussion was limited to the consideration of the characteristics of a perfectly flexible wire suspended from two fixed points of support. Actual wire spans closely approximate this condition, particularly when the successive spans are all of the same length, whether the supporting insulators be of the pin or of the suspension type. In the case of successive spans of unequal length the change in tension in the various spans, due to the variation of temperature and the mechanical load on the wire, will not be the same in each span, and consequently such changes will produce a resultant force on the insulator, causing thereby a slight deflection of the top of the tower; or a deflection of the insulator only, if the latter is of the suspension type. This motion of the points of support will tend to equalize the tensions in the various spans.

In the design of a wire span two problems must be solved: 1. At what tension (or sag) must the wire be strung in order that the tension in the span may not exceed a definite limit under the worst conditions of temperature and of mechanical loading (due to ice and wind); and 2. What will be the maximum vertical sag of the wire for a given variation in loading and temperature? The factors which enter into these two problems are the following:

1. The length of the span.
2. The material of the wire.
3. The size of the wire.
4. The co-efficient of linear expansion of the wire. For copper this co-efficient is 9.6×10^{-6} and for aluminum 12.8×10^{-6}, the temperature in each case being expressed in degrees Fahrenheit.
5. The modulus of elasticity of the wire. The modulus of elasticity for copper or aluminum is not strictly a constant, but may be assumed as such as a first approximation. For copper this modulus varies from 12×10^6 to 16×10^6, depending upon the quality of the wire and upon whether the wire is stranded or solid. The former figure is generally used for stranded copper wires. For aluminum wire, which is always stranded when used for transmission lines, the modulus is equal to 9×10^6. The modulus M is equal to the increase of tension (ΔT) in pounds per square inch required to produce an elongation ($\Delta\lambda$) of a given length of wire (λ) divided by the ratio of the elongation to the original length, i. e.:

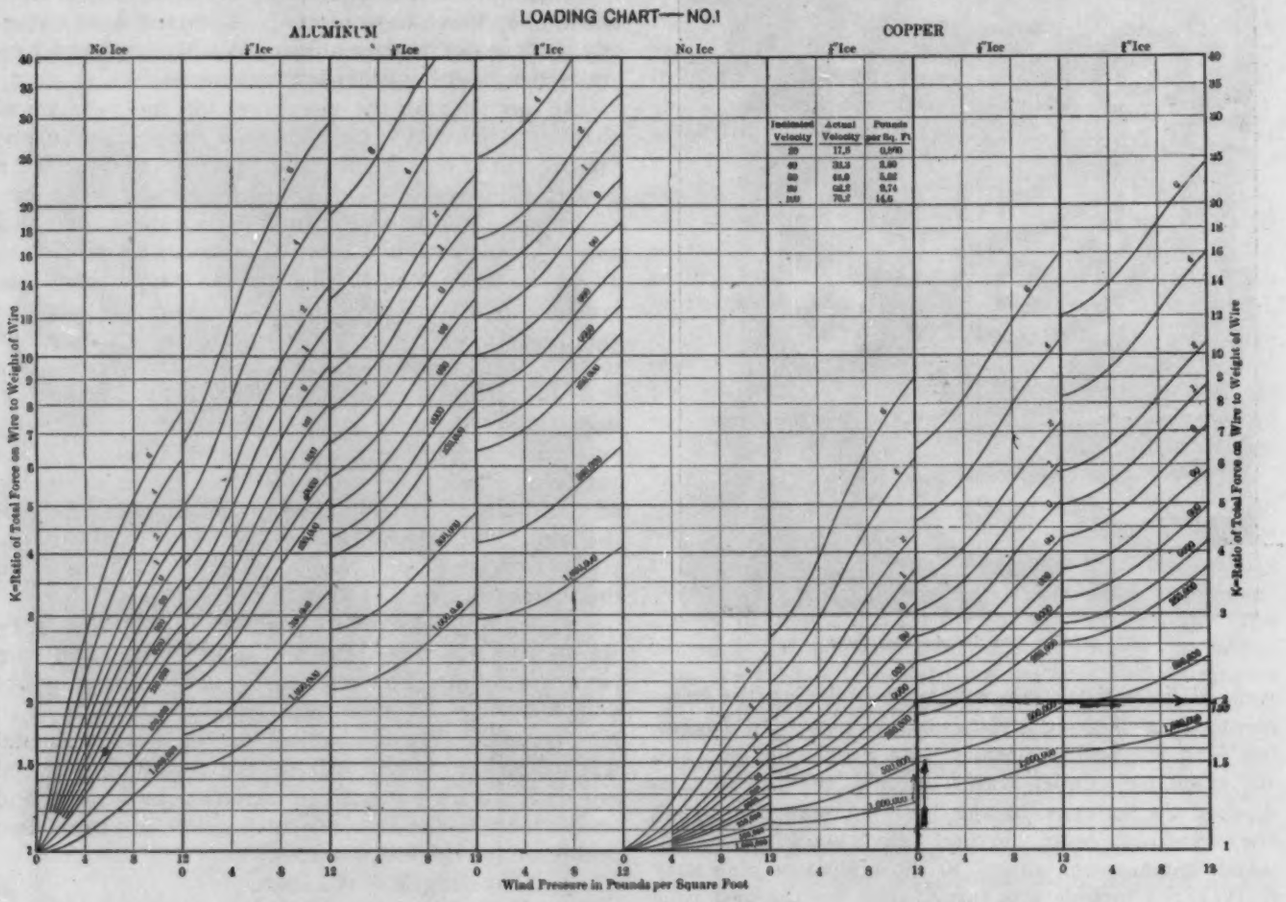
$$M = \Delta T \div \frac{\Delta \lambda}{\lambda} = \lambda \frac{\Delta T}{\Delta \lambda}$$

6. The maximum tension in pounds per square inch to which the wire should be subjected. This maximum allowable tension is usually taken at one-half the ultimate tensile strength of the wire, about 30,000 lb. per sq. in. for copper and 13,000 lb. per sq. in. for aluminum.

7. The maximum external load to which the wire may be subjected due to the collection of sleet on the wire and the pressure of the wind against it. This, of course, will depend upon climatic conditions, but even for a given section of the country, there is considerable difference of opinion as to what should be assumed as a reasonable external load. The Joint Committee on Overhead Line Construction has recently recommended that the maximum loading for high tension crossings be taken as that due to an ice coating 0.5 in. thick all around the wire plus a wind pressure of 8 lb. per sq, ft. of the projected area of this ice cylinder. To meet this requirement on a long span, especially with aluminum wire, would require a relatively large sag, from 30 to 100 ft., depending on the length of span and size of wire. This would require a prohibitive height of tower, at least for level country work. For cross country spans it would, therefore, seem advisable to assume a less heavy loading, particularly as an ice coating of 0.5 in. and a wind velocity of 60 miles per hr. (corresponding approximately to 8 lb. wind pressure) will seldom, if ever, exist simultaneously.

8. The minimum temperature at which the maximum external load occurs. Here again there is considerable difference of opinion, even for given climatic conditions. The Joint Committee on Overhead Line Construction recommends the assumption of a minimum temperature of —20° Fahrenheit for lines situated in the northern part of this country. For cross country spans the assumption of a higher temperature would seem more reasonable, in view of the fact that sleet seldom exists on a wire when the temperature is much below freezing.

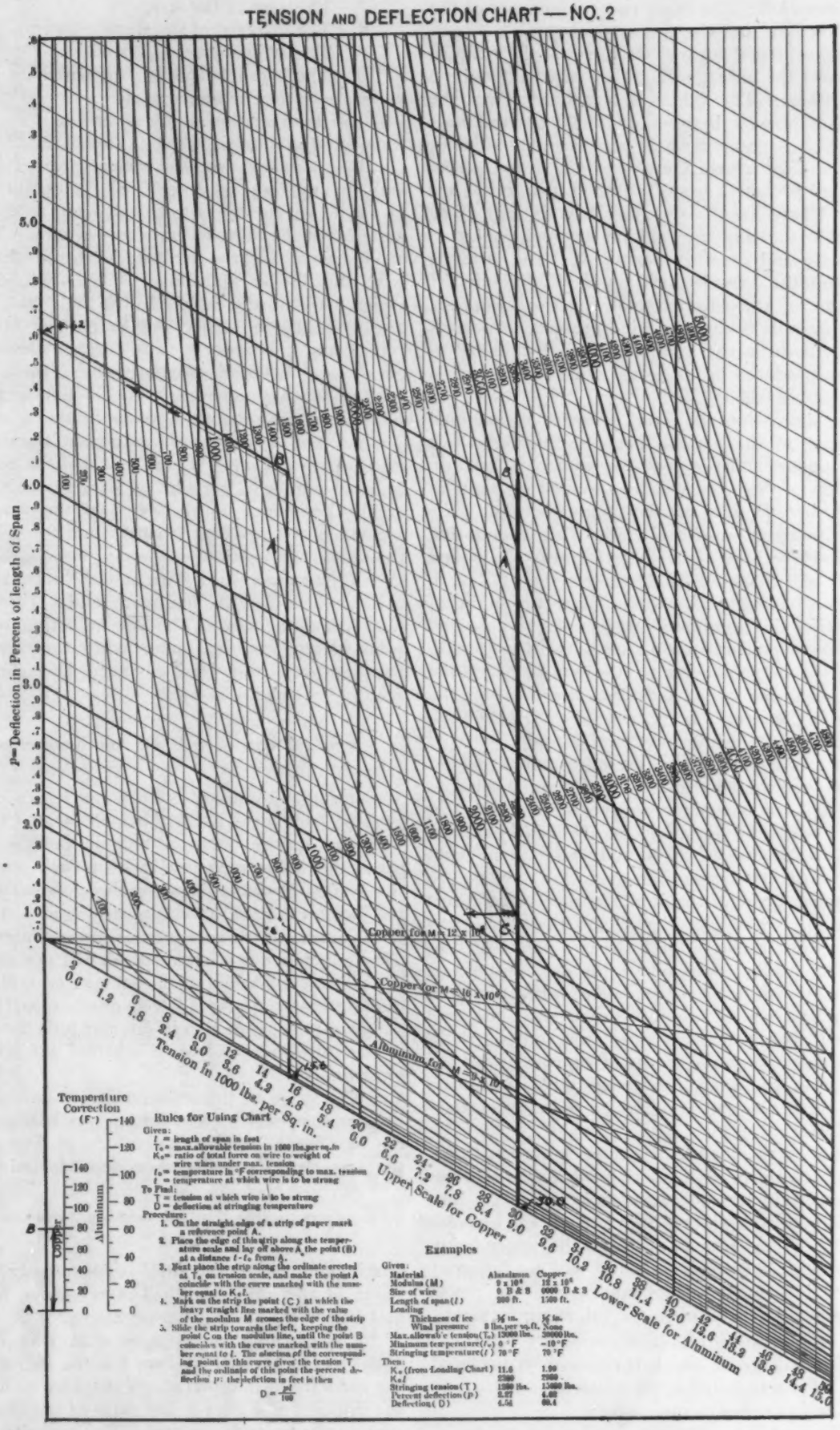
9. The temperature at which the wire is to be strung. As an average stringing temperature 70° Fahrenheit is a reasonable assumption.



10. The maximum temperature to which the wire may be subjected. For lines located in the northern part of this country a maximum temperature of 120° Fahrenheit is reasonable. It should be noted that the temperature of a wire exposed to the sun is considerably higher than the temperature of the surrounding air.

The interrelation of these various quantities in the case of a wire suspended from two fixed points of support were considered in detail.

The total force on a span of wire under any condition of mechanical loading consists in general of three components: 1, its own weight; 2, the weight of the ice coating; and 3, the force acting on it due to wind pressure. It is usual to assume that the wind pressure is horizontal, although it may have a considerable vertical component, particularly if the span is parallel to the


TENSION AND DEFLECTION CHART — NO. 2
p = Deflection in Percent of length of Span
Copper for M = 12 x 10⁶
Copper for M = 16 x 10⁶
Aluminum for M = 9 x 10⁶
Tension in 1000 lbs. per Sq. in.
Upper Scale for Copper
Lower Scale for Aluminum
Temperature Correction (F°)
Copper
Aluminum
Rules for Using Chart
Given:
l = length of span in feet
T₀ = max. allowable tension in 1000 lbs. per sq. in.
K₀ = ratio of total force on wire to weight of wire when under max. tension
t₀ = temperature in °F corresponding to max. tension
t = temperature at which wire is to be strung
To Find:
T = tension at which wire is to be strung
D = deflection at stringing temperature
Procedure:
1. On the straight edge of a strip of paper mark a reference point A.
2. Place the edge of this strip along the temperature scale and lay off above A the point (B) at a distance t - t₀ from A.
3. Next place the strip along the ordinate erected at T₀ on tension scale, and make the point A coincide with the curve marked with the number equal to K₀l.
4. Mark on the strip the point (C) at which the heavy straight line marked with the value of the modulus M crosses the edge of the strip
5. Slide the strip towards the left, keeping the point C on the modulus line, until the point B coincides with the curve marked with the number equal to l. The abscissa of the corresponding point on this curve gives the tension T and the ordinate of this point the percent deflection p: the deflection in feet is then
D = pl/100
Examples
Given:
Material — Aluminum — Copper
Modulus (M) — 9 x 10⁶ — 15 x 10⁶
Size of wire — 0 B & S — 0000 B & S
Length of span (l) — 300 ft. — 1500 ft.
Loading
Thickness of ice — ½ in. — ½ in.
Wind pressure — 8 lbs. per sq. ft. — None
Max. allowable tension (T₀) — 13000 lbs. — 30000 lbs.
Minimum temperature (t₀) — 0 °F — −10 °F
Stringing temperature (t) — 70 °F — 70 °F
Then:
K₀ (from Loading Chart) — 11.6 — 1.99
K₀l — 2380 — 2980
Stringing tension (T) — 1350 lbs. — 13500 lbs.
Percent deflection (p) — 2.27 — 4.62
Deflection (D) — 6.56 — 69.4

base of a steep hill. The other two components of the resultant force on the wire are vertical.

For convenience we will let K equal the ratio of total force on the wire to weight of wire under these same conditions. The values of this ratio K for the various sizes of wire between 1,000,000 circular mils and No. 6 B. & S. gauge for both copper and aluminum, for no ice and for ice thicknesses of ¼, ½ and ¾ in., and for wind pressures from 0 to 12 lb. per sq. ft., are plotted on Chart No. 1. On this chart is also given a short table showing the relation between indicated wind velocity and pressure per sq. ft. The latter is deduced from the formula given by H. W. Buck in the Transactions of the International Electric Congress, 1904; this formula is that the wind pressure in pounds per sq. ft. of projected area of a round cylinder of diameter d produced by an actual wind velocity of V miles per hour is $0.00021\ V^2 d$.

In the discussion the wind pressure is assumed perpendicular to the vertical plane through the two points of support and the pressure per foot of wire in the direction of the wind will be assumed constant at all points irrespective of the angle between the wire and the direction of the wind. This assumption is not strictly realized since the wire near the points of support will make an angle of less than 90° with the direction of the wind, and therefore to obtain an exact solution the wind pressure should be resolved into its two components, one acting in the direction of, and the other perpendicular to, the wind. Since the angle between the wire and the direction of the wind is in general very nearly 90°, the assumption that the wind pressure actually exerted on the wire is equal to the pressure which would be exerted were the wire in a vertical plane normal to the wind will not introduce an appreciable error, in comparison with the variations in the wind pressure which will occur due to the actual variation in wind velocity at different parts of the span.

The general case of the points of support at different elevations is also considered, and the wire is assumed to lie in a plane through the two points of support parallel to the direction of the resultant force. This assumption is not strictly realized when there exists a combination of wind pressure with the two points of support at different elevations, but is strictly true in all cases when the points of support are at the same elevation, and in the former case gives a solution as nearly correct as can be obtained without an elaborate analysis.

When a given amount of electric power is transmitted over a transmission line to a substation or other receiver, a certain amount of power is lost in the line. There is in general a difference in the voltage between wires at the two ends of the line, and the power factor at the sending and receiving ends will be different. The power loss, voltage loss, and change in power factor in general depend upon the following factors:

1. The amount of power delivered.
2. The voltage at which the power is delivered.
3. The power factor at the receiving end.
4. The frequency of the system.
5. The kind of line—three-phase or single-phase.
6. The length of the line.
7. The size of the wires.
8. The material of the wires.
9. The temperature of the wires.
10. The arrangement of the wires on the poles; particularly their distance apart.

The interrelation of these various factors will be considered in detail.

For wires of the size ordinarily used in practice and for any frequency up to 60 cycles, the resistance of a solid wire per unit length depends solely upon the material of the wire and its cross section. A stranded cable has a slightly greater resistance than a solid wire, due to the spiralling of the individual wires which made up the cable. In the table on Chart No. 3 are given the resistance and weight per mile of both copper and aluminum for the various sizes between a No. 16 and 1,000,000 circular mils. This table is calculated for a temperature of 20° Centigrade (=68° Fahrenheit), assuming a temperature co-efficient of 0.42 per cent per degree of Centigrade; the conductivity of copper is taken as 98 per cent and the conductivity of aluminum as 62 per cent of Matthiessen's Standard; and the resistance and the weight of the stranded wires are taken one per cent greater than for solid wire of the same cross section.

The reactance of a wire in ohms is equal to $2\pi f L \times 10^{-3}$, where f is the frequency and L the self-induction in millihenries. The self-induction of a round solid wire of radius a inches when the return wire is parallel to it and at a distance D inches from it (center to center) is

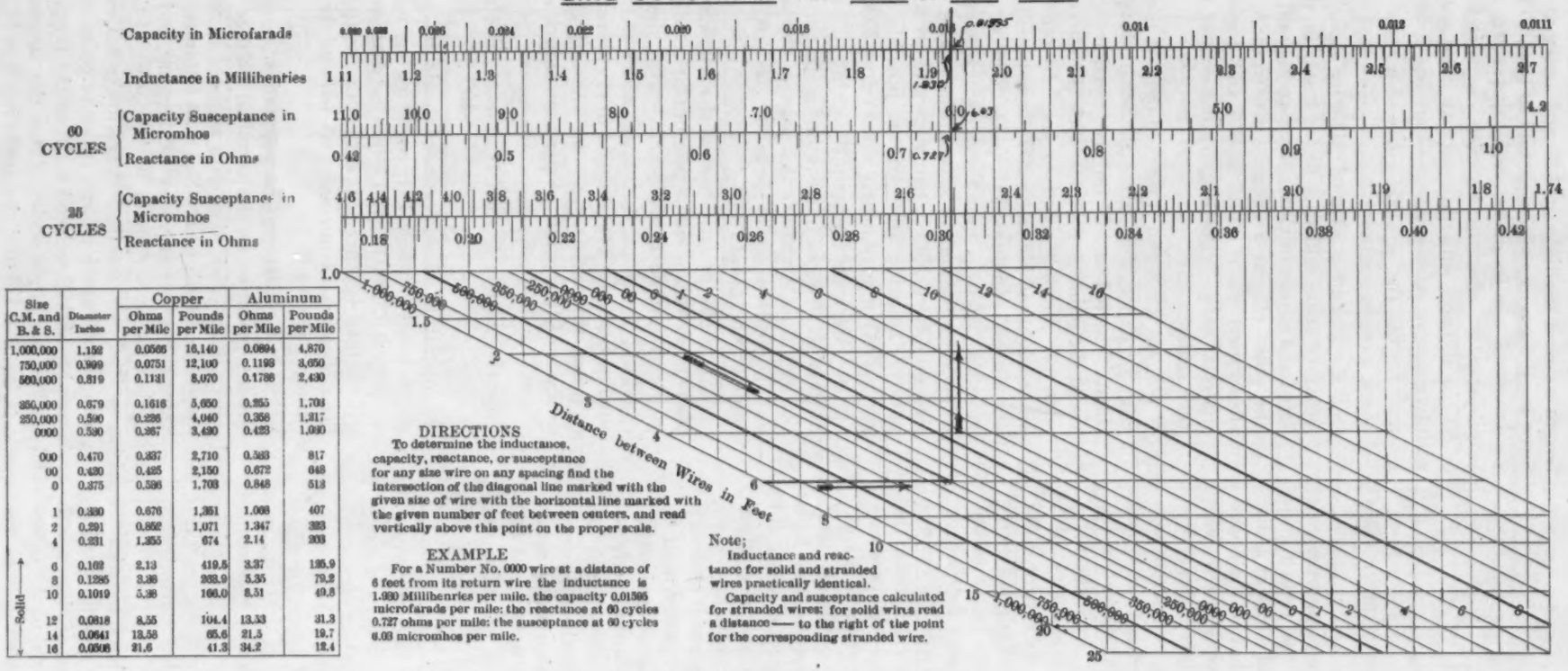
$$L = 0.7411 \log_{10} \frac{D}{a} + 0.0805 \text{ millihenries per mile.}$$

This formula applies also when the return circuit consists of two wires each of which is at a distance D from the wire in question; that is, the above formula gives the inductance per mile of each wire whether the system is single-phase or three-phase, provided in the latter case the wires are arranged symmetrically (i. e., form the three edges of an equilateral prism). The inductance of a stranded wire is practically equal to that of a solid wire of the same cross section of conducting material; for a given number on the B. & S. gauge or for a given area in circular mils the inductance is therefore independent of whether the wire is solid or stranded.

The value of the inductance per mile of wire for various sizes of wire and for various spacings is given on Chart No. 3. This particular form of chart arises from the fact that the inductance depends only upon the ratio $\frac{D}{a}$; consequently all combinations of sizes and spacings for which this ratio is constant give the same value of the inductance. The reactance for both 25 and 60 cycles is also given on Chart No. 3.

The capacity susceptance of a wire in ohms is equal to $2\pi f C \times 10^{-6}$, where f is the frequency and C the capacity in microfarads of the wire to neutral; the susceptance of a wire is the ratio of the charging current to the volts to neutral. The capacity to neutral of a round wire of radius a inches when the return wire

LINE CONSTANTS PER MILE OF ONE WIRE—NO. 3



Size C.M. and B. & S.	Diameter Inches	Copper Ohms per Mile	Copper Pounds per Mile	Aluminum Ohms per Mile	Aluminum Pounds per Mile
1,000,000	1.152	0.0505	16,140	0.0894	4,870
750,000	0.999	0.0751	12,100	0.1193	3,650
500,000	0.819	0.1131	8,070	0.1788	2,430
350,000	0.679	0.1616	5,650	0.255	1,703
250,000	0.590	0.226	4,040	0.356	1,217
0000	0.530	0.267	3,430	0.423	1,030
000	0.470	0.337	2,710	0.533	817
00	0.420	0.425	2,150	0.672	648
0	0.375	0.536	1,703	0.848	513
1	0.330	0.676	1,351	1.068	407
2	0.291	0.852	1,071	1.347	323
4	0.231	1.355	674	2.14	203
6	0.182	2.13	419.5	3.37	126.9
8	0.1285	3.38	263.9	5.35	79.2
10	0.1019	5.38	166.0	8.51	49.8
12	0.0818	8.55	104.4	13.53	31.3
14	0.0641	13.58	65.6	21.5	19.7
16	0.0508	21.6	41.3	34.2	12.4

Solid

DIRECTIONS

To determine the inductance, capacity, reactance, or susceptance for any size wire on any spacing find the intersection of the diagonal line marked with the given size of wire with the horizontal line marked with the given number of feet between centers, and read vertically above this point on the proper scale.

EXAMPLE

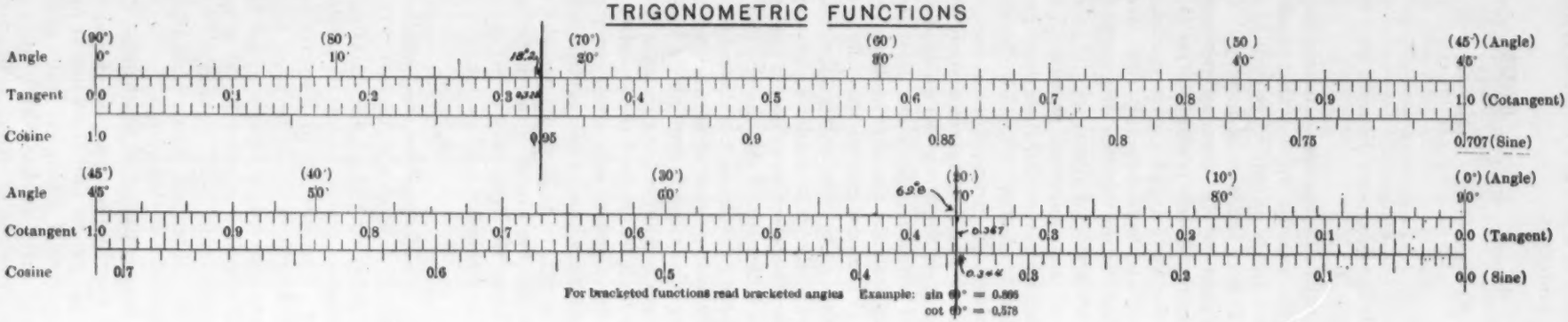
For a Number No. 0000 wire at a distance of 6 feet from its return wire the inductance is 1.930 Millihenries per mile, the capacity 0.01395 microfarads per mile; the reactance at 60 cycles 0.727 ohms per mile; the susceptance at 60 cycles 6.03 micromhos per mile.

Note;

Inductance and reactance for solid and stranded wires practically identical.

Capacity and susceptance calculated for stranded wires; for solid wires read a distance —— to the right of the point for the corresponding stranded wire.

TRIGONOMETRIC FUNCTIONS



For bracketed functions read bracketed angles Example: sin (0)° = 0.866
cot (0)° = 0.578

is parallel to it and at a distance D inches from it (center to center) is

$$C = \frac{0.03883}{\log_{10}\frac{D}{a}}$$

provided $\frac{D}{a}$ is greater than 12 and the distance from the wire to all other conductors is large compared with D. This formula applies also when the return conductor consists of two wires each of which is at a distance D from the wire in question. That is, the above formula gives the capacity per mile of each wire whether the system is single phase or three phase, provided the wires are at a great distance, compared with D, from all other conductors (i. e., overhead lines) and provided that in the case of a three-phase system the wires are arranged symmetrically (i. e., from the three edges of an equilateral prism). The capacity of a stranded wire is greater than that of a solid wire, since its radius is greater. The above formula is not strictly applicable to a stranded wire since the latter is not round, but as a first approximation it may be used.

In Chart No. 3 is given the capacity of the various sizes of wire on various spacings. In calculating the capacity scale the diameter of the wire in each case was taken 15 per cent greater than the diameter of a solid wire of the same cross section; the ratio of the diameter of a stranded wire to a solid wire is approximately 1.15. The proper correction to obtain the capacity of a solid wire is indicated on the chart. The chart also gives the capacity susceptance at 25 and 60 cycles.

The leakage current between wires under ordinary working conditions is negligible. The leakage need be taken into account only in the case the voltage is sufficiently high to produce the so-called "corona effect." This effect appears only when extra high voltages are used and the wires are comparatively small.

The equations plotted upon the charts are accurate in case the length of the line does not exceed 100 miles when the frequency is 60 cycles, or 200 miles when the frequency is 25 cycles.

Example.

Given a three-phase transmission line, 60 cycles, No. 0000 B. & S. wire, 6 ft, apart, 100 miles long, voltage at receiving end of line 60,000, current delivered 100 amperes, power factor of receiving circuit 0.95 lagging. The modulus of elasticity of copper used is 12×10^6, length of spans between towers 1500 ft., no wind encountered, thickness of ice ½ in., maximum allowable tension of wire 30,000 lb. per sq. in., minimum temperature —10° Fahrenheit, stringing temperature 70° Fahrenheit. Determine all the transmission characteristics of this system.

A. Determination of Mechanical Characteristics.

By referring to Chart No. 1 under column headed copper ½" ice, we find black line at foot of chart for 0 wind pressure. Looking vertically upward to the intersection of curve marked "0000," then passing horizontally to the right of chart, we read 1.99. This is the ratio of the total force upon the wire under these conditions to weight of wire. Since the span is 1500 ft. in length we next multiply by 1.99 and arrive at the total force upon the wire, which we find to be 2980 lb. Next we determine the range of temperatures our span will be subjected to, which in this case is seen to be 70+10, or 80° in all, and with this data at hand we proceed with five simple operations on Chart No. 2, as follows:

1. On the straight edge of a strip of paper mark a reference point A.

2. Place the edge of this strip along the temperature scale which is to be found in the lower left-hand corner of Chart No. 2 and lay off above A the point (B) at a distance t-t_0 from A. In our illustration t-t_0 is equal to 80° and copper is the material used, hence employ the copper temperature scale.

3. With A and B marked thus on the straight edge of paper, then place the strip along the ordinate erected at T_0 on the tension scale, and make the point A coincide with the curve marked with the number equal to K_0l. In other words, since we found K_0l to be 2980 lb. in our illustration and since T_0 is assumed at 30,000 lb. in our example, we place our strip upon the vertical line emanating from 30 on the copper scale at the lowest diagonal line on Chart No. 2, being careful to make our point A coincide as nearly as possible with the curve 2980 or very nearly upon curve 3000.

4. Mark on the strip the point (C) at which the heavy straight line marked with the value of the modulus M crosses the edge of the strip. In out illustration the modulus of elasticity was assumed to be $M=12\times10^6$.

5. Slide the strip toward the left, keeping the point C on the modulus line until the point B coincides with the curve marked with the number equal to l or the length of span, which is 1500 ft. in our illustration. The abscissa of the corresponding point on this curve gives the tension T and the ordinate of this point the per cent deflection p; the deflection in feet is then $D=\frac{pl}{100.}$ We find that the operation thus described leads us vertically above point marked 15.6 or stringing tension of our wire is 15,600 lb., and following diagonal line to left we read 4.62 per cent deflection for (p). Thus the deflection of our span of wire of 1500 ft. is found to be 69.4 ft.

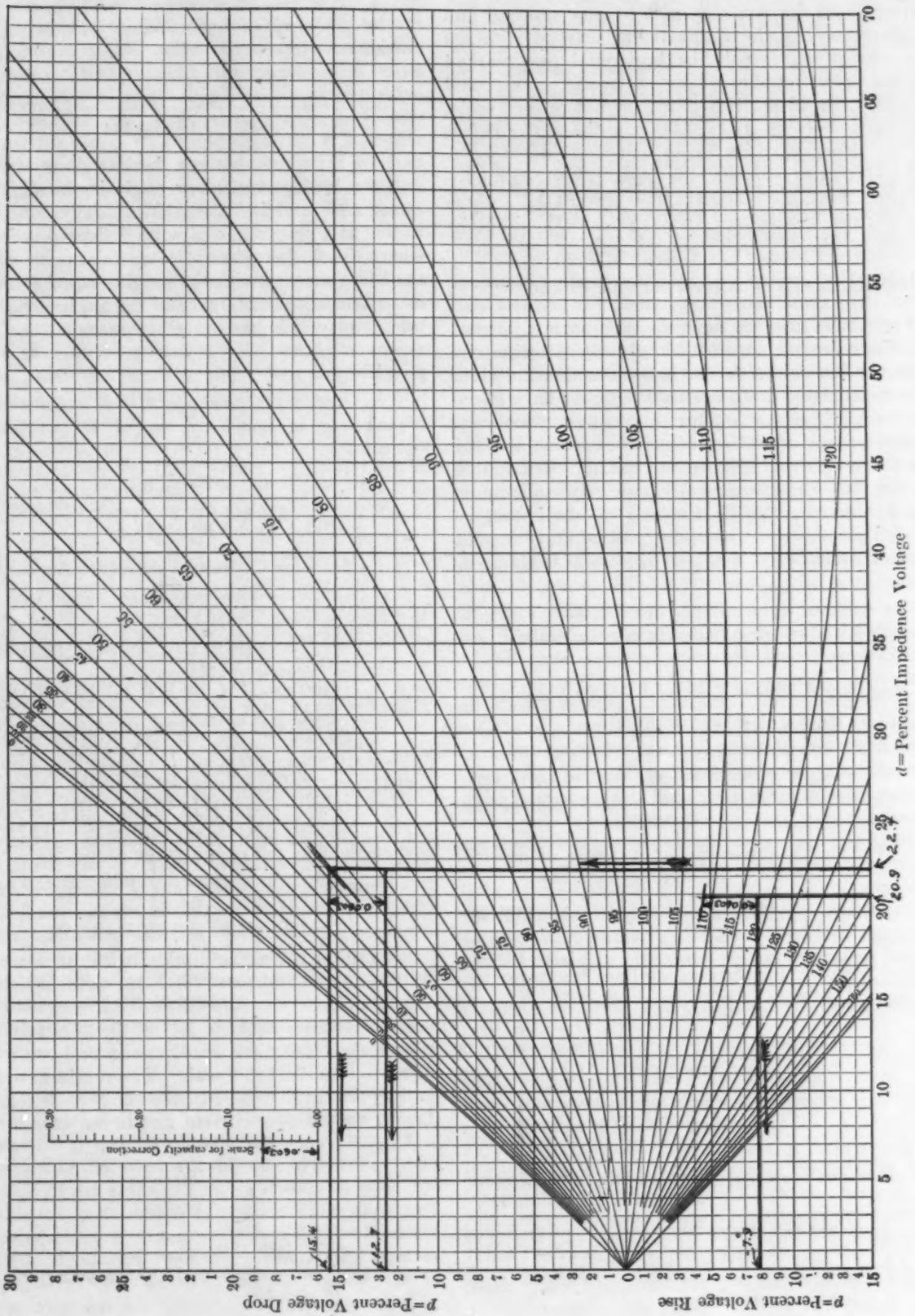
B. Electric Characteristics.

Having given to us the terminal voltage current, and power factor, and other data as listed in our example, we proceed with Chart No. 3 as follows:

Since our power factor is 0.95 lagging, and remembering that the power factor is the cosine of the angle of lag or lead, we consult first the lower scales headed Trigonometric Functions and opposite point on cosine scale numbered 0.95 we read 0.328 on the tangent scale and 18.°2 on the angle scale. Hence the tangent of the angle of lag is 0.328 and the angle itself is 18.°2.

The resistance of No. 0000 copper wire per mile of transmission is easily taken from the table of resist-

CHART NO. 4.


p=Percent Voltage Drop
p=Percent Voltage Rise
d=Percent Impedence Voltage
Scale for capacity Correction

ances on Chart No. 3 and is found to be 0.267 ohms per mile.

To determine the inductance, capacity, reactance, or susceptance for any size wire on any spacing, find the intersection of the diagonal line marked with the given size of wire with the horizontal line marked with the given number of feet between centers, and read vertically above this point on the proper scale. Thus since our wire is No. 0000 at a distance of 6 feet from its return wire we easily find the inductance is 1.930 millihenries per mile; the capacity 0.01595 microfarads per mile; the reactance at 60 cycles 0.727 ohms per mile; the susceptance at 60 cycles 6.03 micromhs per mile, or 6.03×10^{-6} mhs. per mile. Since the equivalent impedance (Z) of receiver per mile of line $=\frac{E}{\sqrt{3}\,l\,I}$ for three-phase line, we have Z = 3.46 in our illustration. Since the tangent of the angle whose cosine represents the line-power factor is the reactance, divided by the resistance per mile of each wire, we have in our illustration 2.62 as the tangent of this angle, which represents an angle of 69.°8, the cosine of which is 0.344 Since the tangent in this case is greater than 1, it is well to reverse the process and divide resistance by reactance, obtaining 0.367. Looking at the cotangent scale of Trigonometric Functions plotted on Chart No. 3 we find similarly 69.°8 as our angle and 0.344 as its cosine.

Our problem now divides itself according as to whether we shall neglect capacity effect or take it into consideration.

Regulation, Power Loss and Power Factor.

Let l = length of each wire in miles.

E = volts between wires at receiving end.

I = amperes per wire delivered to receiver.

k = power-factor or receiver as a decimal fraction.

$\phi = \cos^{-1} k$ = power factor angle of receiver (positive for lagging current).

Z = equivalent impedance of receiver per mile of line.

$=\frac{E}{\sqrt{3}\,l\,I}$ for three-phase line, $=\frac{E}{2\,l\,I}$ for single-phase line.

r = resistance per mile of each wire in ohms (see Line Constant Chart).

x = reactance per mile of each wire in ohms (see Line Constant Chart).

$e = \tan^{-1}\frac{x}{r} = \cot^{1}\frac{r}{x}$ (see scale for Trigonometric Functions).

b = capacity susceptance per mile of each wire in ohms (see Line Constant Chart).

To find q = power loss as a percentage of power delivered.

p = volts lost in line as a percentage of volts delivered.

k_s = power-factor of sending end of line.

A. Capacity Neglected.

1. $q=\frac{100r}{z\,k}=\frac{100\times0.267}{3.46\times0.95}=8.13\%$ in our illustration.

2. $d=\frac{100r}{Z\cos e}=\frac{100\times0.267}{3.46\times0.344}=22.4\%$

and the difference betwen the line power-factor angle and the load power-factor angle is the difference between 69.°8 and 18.°2, or 51.°6. Finally p or volts lost in line as a percentage of volts delivered is found from Chart No. 4. It is the ordinate of the point which is on the curve marked with the number equal to the numerical value of the difference of the angles or 51.6 in this case, and which has the abscissa equal to 22.4, or d, as given above. By referring to the chart we find p = 15.4%.

3. Hence the power-factor K_s of the sending end of the line is found by simple substitution in the equation

$$k_s=\frac{100+q}{100+p}\,k=\frac{100+8.13}{100+15.4}\times0.95=89.0\%.$$

B. Line Capacity Taken Into Account.

1. Calculate q and p as above, neglecting capacity. We have already found these values to be q = 8.13% and p = 15.4%. Then true per cent power loss is

$q' = q - 100\ b\ r\ I^2 \tan\phi$

$= 8.13 - (100\times6.03\times10^{-6}\times0.267\times(100)^2\times0.328)$

$= 8.13 - 0.53 = 7.60\%$.

2. To find the true per cent drop p' measure down from the point corresponding to p on the ordinate scale a distance equal to $b\ I^2$ measured on the "capacity" correction scale. $b\ I^2 = 6.03\times10^{-6}\times(100)^2 = 0.0603$. In performing this operation we find p' = 12.7%, which is then the true per cent voltage drop.

3. To find the current at sending end of line calculate the quantity

$d' = 100\ b\ z\ I^2$

$= 100\times3.46\times0.0603 = 20.9\%$.

Then find on the curve marked with the number equal to $90^\circ+\phi$ or in our case 108.2, the point which has the abscissa d', and measure vertically downward from this point a distance equal to $b\ I^2$ on the "Capacity Correction Scale." In other words, measure down a distance equal to 0.0603 on this scale. The resultant ordinate p_1 is the per cent excess of the current of the sending end I_s over the receiver current and in our case is equal to —7.9%. Hence the sending current is

$$I_s=\frac{100+p_1}{100}\,I$$

$$\text{or } I_s=\frac{100-7.9}{100}\times100=92.1 \text{ amperes.}$$

4. The power-factor at the sending end is

$$K_s'=\frac{100(100+q')K}{(100+p_1)(100+p')}=\frac{100(100+7.60)\times0.95}{92.1\times113.6}=97.7\%.$$

TRANSMISSION SYSTEM OF THE GREAT FALLS POWER COMPANY.[1]

BY M. HIBGEN.

The Great Falls Power Company is at present operating a total of 282 miles of transmission line at 100,000 volts. The principal transmission is from Great Falls to Butte, Montana, a distance of 130 miles. Over this distance two separate, single-circuit, tower lines are used, a single line being extended from Butte to Anaconda, a distance of 22 miles.

All transformers connected to the system are delta connected, this form of connection being very satisfactory in every way.

Above the transmission wires are located two ground wires consisting of ⅜-in. seven-wire, Siemens Martin steel strand, galvanized. These ground wires are clamped to the steel towers and are thus grounded at every tower through the tower legs. The tower legs extend six feet into the earth, and terminate in flat steel feet, which act as ground plates. No additional ground is provided.

The standard span for level country is 600 ft. In hilly country, however, there is no regularity in the length of the spans, and spans of from 1000 to 2000 ft. are common, no special construction being employed except to side guy the towers. The conductors are spaced 10 ft. 4 in., and all three conductors lie in a horizontal plane with no transpositions whatever. The conductor is No. 0 B. & S. gauge, six-wire, hard drawn copper strand with hemp center. The normal clearance of wires from the earth is 29 ft.

The longest span in the line is 3034 ft., and occurs at the crossing of the Missouri River. In this span ⅜-in., Siemens Martin steel strand is substituted for the copper conductors, and a spacing of 20 ft. between wires is employed, two conductors only being supported by each tower. Standard towers and insulators were used, the insulators being doubled.

During the summer severe lightning storms are frequent in the vicinity of the line, and several of these have occurred since the line was put in commission at 100,000 volts but as yet no shut-downs have been occasioned by lightning and only mild discharges have taken place over the lightning arresters. It is believed that the overhead ground wires are largely responsible for this immunity from lightning.

The charging current of 130 miles of single line at 60 cycles and 100,000 volts at the generating end is 39 amperes per wire or 0.3 ampere per mile. This current was measured directly with a high voltage ammeter, and checks closely with the calculated charging current.

The insulators used are of the suspension type and consist of six units, 10 in. in diameter, with the under side of each unit corrugated. The caps and pins are cemented to the porcelain with Portland cement. The insulators have an ultimate strength of approximately 10,000 lb. and will flash over wet at somewhat over 300,000 volts. Up to the present time there has not been a single insulator failure, either mechanical or electrical.

[1]Paper presented at the 28th Annual Convention of the American Institute of Electrical Engineers, Chicago, Ill., June 26-30, 1911.

It is true that shortly after the line was erected an insulator was shot in two by a high powered rifle, the bullet cutting a deep groove in the forged steel pin, cutting in two the clevis ears and destroying the porcelain of one unit. This, however, could hardly be classed as a failure.

No difficulty has been experienced with the insulators swinging in the wind. With a 60-mile wind blowing at right angles to the line it is believed that the insulators will swing side-ways and stand at an angle of approximately 40 deg. with the vertical. The maximum deflection observed so far, however, has not been over 30 deg. A considerable deflection has been noticed in insulators which are located between a long span and a short span due to changes in temperature. The tension in a short span varies more with changes in temperature than does the tension in a long span, consequently during cold weather the insulators deflect along the line toward the short span while in hot weather the deflection is in the opposite direction. This action deserves considerable attention, and to accommodate the different positions of the insulator at different times of the year a wire clamp should be employed with a long bearing surface on the wire and a relatively short distance between the wire and the hinged point which supports the clamp. This form of clamp is desirable to prevent a sharp bend in the wire when the insulator stands at either extreme of its swing.

The line is controlled at each end by 100,000-volt oil switches, solenoid operated, having a double vertical break. The switches are top connected through oil filled bushings. These switches have been entirely satisfactory and have readily broken the short circuit current supplied by the 21,000 kilowatt plant feeding the lines. To sectionalize the line out-door, double air break switches are used of the three-pole, revolving arm type. The switch blades and jaws are mounted upon pedestal insulators made up of six insulator units in series very similar to the regular suspension insulators except that the cap of one unit is extended upward to form the pin of the next, thus making the insulators as a whole rigid. These switches have not as yet been used to break any charging current but from the standpoint of good insulation and mechanical strength and ease of operation, they have been very satisfactory.

The charging current of the line is at present entirely supplied by the main generating plant, which has a total capacity of 21,000 kw., divided into six generating units of 3500 kw. each.

The output of two generating units is utilized near the generating plant, consequently there are at present installed only four banks of 100,000-volt step-up transformers, each bank having a capacity of 3,600 kw. The charging current one line is well above the normal rated capacity of one generating unit. It has been found, however, that one generating unit and bank of transformers can readily supply the charging current of one line for a short time.

The plant is now fully loaded with an induction motor load and the lagging current taken by the induction motors so nearly balances the charging cur-

rent of the line that the power factor at the generating plant averages 99 per cent.

There are installed in Butte three 1200-h.p. synchronous motors direct connected to air compressors. These are not yet connected to the line but will be in a short time, and it is expected that they will aid slightly in regulating the voltage at Butte.

The 100,000-volt outlets at the Rainbow Plant and at the Butte substation, as well as the switching station at the middle of the line, are through the roofs of the buildings. Oil filled porcelain bushings are used, and these have proved entirely satisfactory. All transformer bushings and switch bushings are oil filled and as yet have caused no trouble.

Electrolytic lightning arresters are used at both ends of the line and in the middle, the latter being installed in the switching station. These arresters have discharged during lightning storms, and usually discharge when any high tension switching is done.

The original pedestal insulators upon which the horn gaps for these arresters were mounted proved weak mechanically. Two insulators broke off at the bottom connection without apparent cause. These have since been replaced with the type of insulator used on the line-sectonalizing switches and no further trouble has been experienced.

The line has successfully withstood winds estimated at 60 miles per hour, and has been through one sleet storm where sleet formed on the wires "to a diameter of six inches," as reported by one patrolman. This, however, was doubtless an exaggeration.

When the line was first put in commission corona was plainly visible on every live part of the system. The corona gradually became less until after about three weeks no corona at all was visible except in a few places in the stations, such as the points of switch blades and other sharp projections. It is believed that this corona formed on small points or other roughnesses caused by the rough handling of the wire and that these have gradually worn off or burned off.

A private telephone line parallels the transmission line from Great Falls to Butte. This line is erected on wooden poles and runs midway between the two tower lines at a distance of 30 ft. from each. There was considerable static and much noise on this line when first put into operation. Reactance coils bridged across the line with their middle points grounded were installed at each end of the line and in the middle, and these reduced the induced voltage to about 50 volts between wires and ground, and did away almost altogether with the noise. The line now gives excellent service, and is easier to talk over than the lines of the Bell Company.

At no load there is a rise in voltage on the line of 3.5 per cent. With a load of 15,000 kw. at 85 per cent power factor on the two lines the drop in voltage is 7 per cent. With all this load on one line the drop in voltage is 17.5 per cent. Taps are provided on the high-tension winding of the step-up and step-down transformers, and the step-down transformers are connected on a 10 per cent lower tap than are the step-up transformers thus compensating for a drop of 10 per cent. When it is necessary to carry the full load on one line the generating plant raises its voltage 10.5 per cent to take care of the additional drop.

The switching station, which has been referred to, will provide a cross-over in the middle of the line so that it will be necessary to cut out only half of one line in case of accident. This will considerably improve the regulation of the line as a whole.

The towers have four legs and a single horizontal cross arm. The wires are supported at the two ends and in the middle of the cross arm and hang 40 ft. from the ground at the tower. The cross arm is supported at two points, each midway between the middle wire and the outside wire. The two ground wires are supported above the cross arm near its points of support.

The tower is composed entirely of angles and flats, all connections being by means of bolts. The cross arm is made of two 4-in. channels placed back to back and separated in the middle. The tower is erected on four angle iron stubs set six feet in the ground, the bottoms of these stubs terminating in flat feet made of short pieces of channel section having an area of 144 sq. in. each. All parts of the tower are galvanized.

The system has been operating at 100,000 volts for six months and nothing has developed as yet to indicate that the operation of a 100,000-volt system is any more difficult than the operation of a 50,000-volt system. On the other hand, it is believed that the extra high insulation provided for this voltage prevents many break downs, due to lightning and surges, which would occur on a system operating at 50,000 or 60,000 volts with insulators designed for a factor of safety of two or three, as is common with such systems.

After all, the normal voltage of a long transmission system has little to do with the voltage which must be insulated against. It is the abnormal voltages, caused by lightning, switching and accidental grounds, which really test the insulation of a system such as this.

CHINESE IRRIGATION PUMPS.

Machines for raising water for irrigating purposes are constructed entirely of wood, long chains of paddles running from the stream to a wooden shaft whose wooden cogs fit into others on a wooden wheel on shore. This wheel is turned by a water buffalo, which blindfolded to prevent dizziness, plods in slow circles, supplying the power that brings the needed current to the level of the fields. This machine and the buffalo are the most important possessions of the farmer in China; the latter has probably been bred on the premises and the former constructed by the village machinist at small cost, so that little coin value is represented.

On farms too small for the buffalo and wheel it is usual to see two men with a scoop of closely woven bamboo, swung between them on a rope of the same material, keep a stream of water moving from one level to another for 10 minutes at a time, resuming operations after a short rest of about 5 minutes. It is said that these men raise not less than 1500 gallons of water per hour.

Besides turning the irrigator, the buffalo also turns the stone to grind rice into flour, pulls the plow, and, if female, supplies milk to the family. This animal is both horse and cow to the local farm.

SOME UNEXPLORED FIELDS IN ELECTRICAL ENGINEERING.[1]

BY DR. C. P. STEINMETZ.

In discussing the subject of the unexplored fields of electrical engineering, we must consider as belonging to the realm of the electrical engineer, all those phenomena of electricity that are of importance to man; those which are beneficial and useful, and utilized in doing the work of the world, and also those phenomena which are harmful and destructive, and therefore to be guarded against.

In some fields of electrical engineering or of electrical science we might almost say that we know less now than we knew, or rather believed we knew, a quarter of a century ago. There are things which had been investigated a quarter of a century ago and which were explained in a satisfactory manner to our limited knowledge in the early days, but this explanation does not seem satisfactory now with our greater knowledge.

A curious example we might cite from the textbooks on natural history, for instance. There are supposed to be some fishes which are capable of giving electric shocks. There are some species of gymnotus in the South American mud creeks capable of imparting electric shocks, which have been described a number of times, fishes which have an organ which generates electricity. It has been described as being constituted like a Volta-pile, of a number of successive cells. That theory was quite acceptable twenty-five years ago, but is not satisfactory now. To give a severe shock would require about 500 to 1000 volts, and it is not intelligible how such voltage could be generated in the conducting animal tissue without being short circuited. Furthermore, the fish is immersed in water, which is a fair conductor, especially sea water, and 500 volts or more would produce hundreds of amperes in the surrounding water, representing hundreds of kilowatts, and it is not intelligible how such a large power could be generated even momentarily. Thus here we have a mystery, because, after all, the descriptions have been so concise that it is difficult to doubt that there are fishes which can give electric shocks. Just why that phenomena has not been investigated by electrical engineers, we do not know, especially when considering that one of the electric fishes, raja torpedo, lives in the Mediterranean and is frequently caught on the Italian shores, as claimed, thus is within easy reach of engineers.

But we do not need to go so far from home; right at hand we have some of the most important uninvestigated phenomena of electricity. The thunderstorm, the lightning, and so forth. In the early days lightning was explained as the discharge of the clouds. The clouds are positively charged, and the ground is negatively charged, and the spark jumps from the cloud to the ground. Speculations were made as to how the clouds became charged, and as then the only method of producing electricity was by friction, it was said it might be the friction of the vapor through the air, or the rain drops through the air, or some other form of friction. That explanation used to appear satisfactory, but with our present knowledge of dielectric phenomena, it is not satisfactory any more.

It was thought that lightning was the discharge from the cloud to the ground. That means that the electric field between the cloud and the ground must be beyond the breakdown strength of air. In a uniform field the breakdown strength of air is about 75,000 volts per inch, or nearly a million volts per foot. Even if the cloud is only 1000 feet above ground, this would require a thousand million volts. If there were an electrostatic field between the cloud and the ground of a thousand million volts extending over the whole area of the thunder cloud, this would represent such an immense amount of electric energy that it is inconceivable how any reasonable source of energy can produce it; how it can exist without having a destructive effect far beyond anything known of lightning. Furthermore, a uniform field cannot well exist between clouds and ground, on account of the unevenness of the ground surface.

We cannot consider the lightning discharge as a simple electric rupture in the same way that an overloaded beam may break mechanically, but as an equalization of internal stresses, about as a piece of hot glass that is rapidly chilled, and thereby full of internal compression and tension strains may suddenly break all over by the internal stresses. So with our present knowledge we must consider as the most probable explanation—although not certain by any means—that the lightning discharge is the phenomenon of the equalization of internal electric stresses in the cloud, and is analagous to the splintering or breaking of an unevenly stressed brittle material, like glass.

Lightning discharges are the result of the voltage inequalities produced in the clouds by the unequal rate of conglomeration of rain particles due to the unequal cloud density.

In agreement with this is that heavy lightning strokes are usually followed by a heavy downpour of rain; in reality they are preceded and caused by it, but it takes time for the rain drops to come down.

The lightning rod is a great protection, and I would not like to be in an exposed place without such protection. But you must not expect that one rod on one end of the building will completely protect the other end a hundred or more feet away. There must be sufficient rods to extend their protective zone over the entire area; the apex of the roof, and other projecting edges must be protected by connecting wires, etc. That is, like any other apparatus, the lightning rod protection must be installed intelligently and properly to be effective. But the general principle is correct, only it must be rationally applied.

We now find that in the study of electrostatics the conceptions of the work of former days is untenable, from our present point of view; we cannot conceive of the dielectric phenomena as a charge on the conductor surface; we know there is not an electric charge on the conductor, the dielectric energy resides not on the conductor surface, but is in the space around the conductor in a dielectric field, and the so-called "charge" is nothing but the termination at the conductor surface of the electrostatic field in space.

[1]Abstract of paper presented at the joint meeting of the Electrical Section of the Franklin Institute, Philadelphia, and the Philadelphia Section of the American Institute of Electrical Engineers, and printed in the June number of the Journal of the Franklin Institute.

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Exposition Site

Although we have formed decided views regarding the proper location for the big Panama-Pacific Fair, we are inclined to allow the proper persons, acting in their public - spirited manner, decide this important question. The Fair Commissioners are eminently qualified to make the selection best suited to the requirements of this great project and when the site is chosen let everyone forget the discussion and differences that have arisen and become boosters for the greatest exposition ever undertaken. Exploitation of all Pacific resources should be the password. Above all, however, we are most interested in the especial exploitation of Western power developments and there should be such an electrical display put forth that the whole world will ever carry in mind this dazzling picture of supremacy.

Transmission Line Charts

The cumbersome and intricate formulas necessary in the study of alternating current phenomena have either led many engineers to other fields of research or limited them in a proportionate advance in this branch of the profession. To completely analyze a transmission system under given conditions at the receiving end is a problem requiring the utmost skill and care in computation. A signal advance was made in the profession when Harold Pender and H. F. Thompson worked out the equations from which the charts presented in this issue were drawn.

There are many engineers who are not given to reasoning in symbols. Give them charts so they can readily work out concrete examples and thus study the relationship from this point of view and they are quite at home. Many of our most practical men are of this type. It may develop that for many cases these charts cannot be read to a sufficient degree of accuracy to use in practice. Should this prove to be the case they will nevertheless be of inestimable value in checking up many kinds of computation in transmission line data. Hitherto there has been nothing to serve as a check in this work.

New Method Land Appraisement

The question of a proper valuation of property in case of condemnation proceedings at court is difficult of solution. On the day set for trial it is usual to see each side marshalling its forces in preparation for the conflict. Each side introduces its set of expert witnesses who swear to the merits of their respective contention, although there is but one proper value. Sales of real estate in the vicinity are a great aid in arriving at a value and yet it is often the case that no sales have been recent enough to be acceptable. To get unbiased expert witnesses to establish the proper value is most difficult.

In the current issue of Engineering and Contracting, the editor, H. P. Gillettte, well-known as an expert on "cost data," has set forth a meritorious method which should command the respectful consideration of all interested in valuations. The author calls it "Capitalized Rental Method." The necessary steps in arriving at land values by this system are five in number. First determine the rental paid for real

estate contiguous to and similar to the property to be appraised. Second, estimate the cost of the buildings on the land whose rental price is known. Third, estimate the fair annual rental for the capital invested in the buildings alone, and to this add insurance, taxes and annual depreciation of buildings. Fourth, deduct this total from the total rent received for the land and buildings, and the balance will be the land rent and the amount thus ascertained is the value of the land.

This suggestion adds much toward a proper determination of appraisement for particular prices of land and especially is it useful in well-established localities in cities. It seems, however, almost impossible in many of the newer localities of the West to use any particular rule or method. A favorite scheme used by witnesses for the defendant in a case of considerable local interest near Missoula, Montana, some three years ago when the Northern Pacific Railroad Company and the Chicago, Milwaukee and St. Paul Railroad desired a joint right-of-way through a certain widow's property, was to capitalize the rental on a fruit-bearing basis. The land was only of moderate fertility, with but a small portion planted to apple trees, and by public road six miles from town, yet this plan, backed up by the blushing appearance of the widow and her children in court, led the Board of Appraisers to award her over $40,000 for the strip desired.

The method of showing the productivity of land and its earning capacitiy in the West is subject to so many fallacies that it should be used with great care. Even on the basis of potato yield the land can be shown to have enormous values, yet the rentals themselves do not give such return, year in and year out, on this basis of calculation. As years go by and conditions become more settled no doubt this method for farm values will prove of service. It is to be hoped that some satisfactory means, similar to the Capitalized Rental Method in cities, can be worked out for the rural districts throughout the West. As land values are so fluctuating and uncertain it is doubtful whether this can be accomplished with any degree of accuracy. Consequently the great corporations desiring rights-of-way will in a large measure have to endure exorbitant costs.

Engineer's Relation to Teaching

No other technical profession is subject to such continuous changes in theory and practice as is that of electrical engineering. Being a profession built up within the past two decades, it still has the energy and vigor of youth, with a future bright before it. Unquestionably, during the next two decades it will experience even greater and more radical changes. It seems but yesterday since there was completed the installation of Louis Bell that transmitted power from San Antonio Canyon in Southern California to the city of San Bernardino, some twenty miles away. How the neighboring people used to swell with pride as they informed awe-inspired visitors that this was the longest electrical transmission line in the world! Compared with the present giant lines in the Sierras and Rockies, with distance of transmission running into hundreds of miles and voltages reaching the hundred thousand mark, the human mind can scarcely grasp the fact that twenty years could so enlighten a profession as to lead men to dare to accomplish such a control of natural forces.

In fact, changes are coming so rapidly, that what was yesterday's theory and practice is discarded to-day as so much mental and material junk. To keep pace with this gigantic development and to carry it to still farther heights requires the best brains and talent in the profession, and the designing and installation of these enterprises have developed some of the brightest minds of the nation. The great industries have vied with each other in their search for brains. So constantly are new methods replacing the old that a necessary innovation is introduced in the teaching of the profession in the universities. The impetus of this great movement made itself felt upon the university life, first, by taking away from the technical institutions many of their brainiest men. Of all the professions in America to-day, the highest, that of the college professor, is uniformly recognized as the least remunerative.

The great industries have gone far and wide in search for their experts. These experts become not only captains of industry, but invent and conceive new ideas and theory regarding the engineering profession. In the great technical schools there is felt the utmost need for men of theoretical natures but eminently practical. Students looking forward to practical life need men ripe in experience for maximum benefit, yet the comparatively small salaries paid in our American university faculties have made their technical department sadly in danger of losing their brilliant men.

It is gratifying to note that a new era is dawning upon our educational developments. The happy thought of retaining engineers of note or of calling such men to university chairs and allowing them to combine in a definite manner university work with outside practice seems to be adjusting itself more and more. The time is past when the college professor can wilfully neglect his college duties to engage in outside practice. Many unfortunate experiences of the past have demonstrated this, but purely theoretical engineers are of little service either to the university or the engineering profession. An opportunity to put theory into practice is essential. A different arrangement whereby it is strictly understood that university work is in no wise to suffer by such practice as may be undertaken and that university work is to come first seems to bring about maximum good results. Thus is presented to the student for his instructor, well-rounded engineers, up-to-date in practice and up-to-date in theory.

The more this combination can be crystalized, the more will the university chair attract our great engineers. With part of their time to deal in theory and part for consulting work they will feel that the sacrifice financially is not too good and thus will result for the young engineer the highest type of engineering instructor.

Illustrations of this late idea are numerous. C. P. Steinmetz has been called to Union College, Wm. Kent to Syracuse University, and last, but not least, Chas. F. Scott to head the electrical engineering department at Yale.

PERSONALS.

F. F. Skeel, of the Crouse-Hinds Company, is at San Francisco.

F. G. Baum has returned to his San Francisco office from Shasta County, Cal.

H. H. Sinclair, formerly manager of the Great Western Power Company, is at Los Angeles.

C. Gaylord, an electrical engineer of Pasadena, was a San Francisco visitor during the past week.

K. G. Dunn, electrical engineer with Hunt, Mirk & Co., spent the past week at Denver on business.

F. A. Cressy, who has electric lighting interests at Modesto, was at San Francisco during the past week.

Edward Averill, the Portland manager of the Forbes Supply Company of Seattle and Portland, is at San Francisco.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, arrived at San Francisco last week from Milwaukee.

Hugh L. Thomas, superintendent of the Salt Lake Telephone Company, was at San Francisco during the past week.

H. B. Squires, of Otis & Squires, San Francisco, is receiving the congratulations of his friends on the arrival of a daughter.

W. S. Hoag of the Los Angeles office of the Westinghouse Electric and Manufacturing Company, was a recent San Francisco visitor.

H. A. Sayles, with the Holabird-Reynolds Company, went to Santa Catalina Island to attend the State Convention of the Electrical Contractors' Association.

J. E. Woodbridge, engineer in charge of the San Francisco office of Ford, Bacon & Davis, engineers, recently returned from a vacation tour to the Hawaiian Islands.

Mr. Ames, head of the National Electric Company, was one of the San Francisco delegates to the Electrical Contractors' Convention at Santa Catalina Island.

Edward Ayden, auditor of the Portland branch of the Pacific States Electric Company, returned to Oregon during the past week after visiting the main office at San Francisco.

Leon M. Hall returned to his San Francisco office during the past week from a trip to Reno in connection with the engineering work on an electric power development in Nevada.

W. W. Low, president of the Electric Appliance Company, celebrated his silver wedding anniversary by a dinner to a large number of friends at the South Shore Country Club, Chicago.

Samuel Napthaly, general manager of the Great Western Power Company, has returned from a trip to the new dam site at Big Meadows, in company with P. T. Hanscom, general superintendent.

W. S. Hanbridge left last Saturday by steamer for Los Angeles, with a large party of excursionists representing electrical firms, who went south to attend the convention of Electrical Contractors at Santa Catalina Island.

H. D. Donnell, assistant manager of the Safety Car Heating and Light Company of New York, returned to his San Francisco office last Monday after an extensive Eastern tour. He attended the conventions of the Master Car Builders and the Master Mechanics at Atlantic City, besides visiting several manufactories.

John Ripley Freeman, a past president of the American Society of Mechanical Engineers, and consulting engineer for the New York Board of Water Supply, recently arrived at San Francisco, where he is engaged in a consulting capacity by the city government in connection with water works investigations. Allen Hazen, a prominent New York engineer, preceded him to the city, having been employed by the Board of Works to examine and make a report on the water supplies of San Francisco from a filtration standpoint.

W. S. Heger has resigned as manager of the San Francisco and Los Angeles offices of the Allis-Chalmers Company, his duties being assumed by Fred L. Webster, newly appointed Pacific Coast manager for the company. He has endeavored t. bring this about for nearly two years and will now retire from active business life, making his home in Marin County, California. Mr. Heger is one of the pioneers in the machinery business on the Pacific Coast, having opened the San Francisco offices of what has since become the General Electric Company in 1889. Resigning in 1891 he went East, but returned in 1895 to establish the office of the Westinghouse Electric & Manufacturing Co., being Pacific Coast manager until 1905, when he resigned to become assistant to the president of the Allis-Chalmers Company. In 1909 he returned to the Coast to take charge of their California business. It is with heart-felt regret that his many friends have learned of his decision to retire and it is their sincere hope that he will find pleasure in rest.

Fred L. Webster, who has just taken charge of the Allis-Chalmers Company's Western interests, with the title of Pacific Coast manager, will make his headquarters at San Francisco, visiting the branches at Los Angeles, Portland and Seattle from time to time. His jurisdiction will extend from the Mexican boundary north, including Alaska. After building up his company's business in the Northwest during the past few years as manager of the Seattle office, Mr. Webster comes to San Francisco well equipped for the management of the entire Pacific Slope. Although Mr. Webster is already well and favorably known in engineering circles, a sketch of his previous career may be of interest. He joined the E. P. Allis Company in the erecting department, in 1892. Subsequently he did a great deal of foreign work for their factory, spending four years in South Africa. On his return from Africa, in 1891, he became chief engineer of the St. Louis Transit Company, holding that position until 1893. Then he went with the Fulton Iron Works, St. Louis, as sales manager, handling Corliss engines principally. In 1895 he returned to the Allis-Chalmers Company and was for two years head salesman of their Chicago office. Then he came to the Coast as manager of the Seattle office, which position he has held for the past three and a half years, his territory covering Washington, Oregon and British Columbia.

TRADE NOTES.

The Aylesworth Agencies Company of San Francisco has taken on the line of the Steel City Electric Company, of Pittsburg, including lock nuts, conduit boxes, etc.

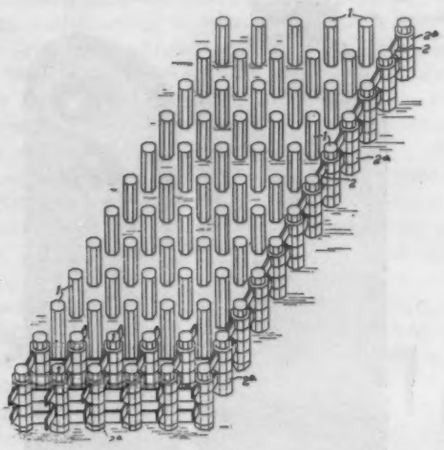
The General Electric Company has sold to the Robinson Manufacturing Company, of Everett, Wash., a condensing Curtis turbine rated as follows: One A. T. B. 2, 750 kw., 3600 r.p.m., 480 v., horizontal, Curtis turbine generator.

NEW BULLETIN.

The Kelman Electric and Manufacturing Company of Los Angeles are distributing through Pierson, Roeding & Co., Bulletin No. 7, which deals with high voltage oil switches and oil circuit breakers. The bulletin is profusely illustrated with various types of switches from 75,000 hand operated to 30,000 volt apparatus. Sectional details are shown of the interior workings.

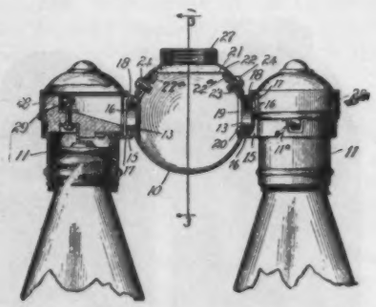
PATENTS

996,843. Seawall or Wharf Construction. Charles F. Francisco, San Diego, Cal. A seawall or wharf construction comprising, a plurality of reinforced concrete piles spaced apart,



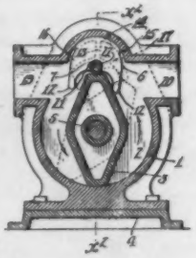
a plurality of reinforced concrete locking and interlocking collar beams, and a plurality of ball bearings adapted to reduce the friction of vessels in contact with said piles, all substantially as set forth.

996,963. Electric-Lamp Cluster. Reuben B. Benjamin, Chicago, Ill., assignor to Benjamin Electric Manufacturing Company, Chicago, Ill., a corporation of Illinois. An electric lamp cluster comprising a hollow supporting body having a plurality of apertures therein; a plurality of lamp sockets, each lamp socket having a casing shell formed with a hollow boss ex-



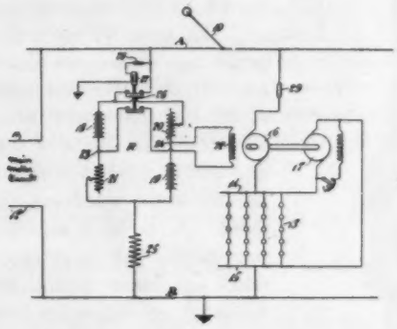
tending at right angles with the axis of the lamp and having an aperture formed therein; and means for securing the outer faces of said hollow bosses directly against the outer surface of said supporting body in such manner that the apertures of the bosses will respectively register with the apertures of the supporting body.

996,984. Pump. John Grindrod, Bakersfield, Cal. In a pump, the combination of a casing provided with an inlet and an outlet and having a cylindrical chamber and a channel therebetween, an elliptical runner rotatably mounted in the casing, and an abutment rotatably mounted in said channel and provided with two lips, each lip being of a greater length from the pivot of the abutment to its tip than from said pivot to the wall of the channel, but of a less length than the distance from said pivot point to the junction of the wall of the chamber and the walls of said inlet and outlet, respectively, whereby the pressure of the fluid being expelled will hold one



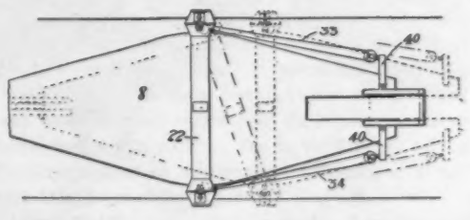
lip in contact with the runner at all times without causing the other lip to close the inlet.

996,894. System of Electrical Distribution. Emmett W. Stull, Milwaukee, Wis., assignor to Allis-Chalmers Company, a corporation of New Jersey. In combination, a circuit of variable voltage, a second circuit supplied therefrom, a generator in the connection between the two circuits, and a Wheatstone bridge connected across the circuit of variable



voltage and having arms in opposite ones of which the drops in voltage vary proportionately and in adjacent ones of which the drops in voltage vary disproportionately as the voltage of the variable voltage circuit varies, the field winding of said generator being connected in the bridge wire of said Wheatstone bridge.

997,247. Dredge. Walter Ferris, South Milwaukee, Wis., and Paul Revere Parker San Francisco, Cal., assignors to The Bucyrus Company, South Milwaukee, Wis., a corporation of Wisconsin. A dredge having an anchoring structure pivoted to



the deck thereof, power operated mechanism connected directly with said structure and by means of which the dredge is swung laterally in either direction with said anchoring structure as a stationary pivot, and excavating mechanism carried directly by the dredge hull.

INDUSTRIAL

SELECTIVELY OPERATED SEMAPHORE AND TELEPHONE EQUIPMENT.

Since the development of the telephone for train dispatching, a need has been felt for signaling equipment which could be used and operated in connection with a telephone train wire. That is, instead of having a selector on a telephone circuit ring a bell at a way station, it was required that it should throw a semaphore arm. The Western Electric Company, in conjunction with the Union Switch and Signal Company, has for some time been developing apparatus to meet this particular need, and a description of the new apparatus and its uses is given here.

Fig. 1. Signal Post.

Both steam and electric railroads offer an extensive field for use for this selectively operat d semaphonre in connection with the telephone system. On steam roads it wi l probably be used exclusively for train order work. In other words, it will be em- loyed as an auxiliary to a regular telephone train dispatching system. When used in tnis way it will secure a stul further saving than is now effected by the telephone.

The new Western Electric semaprore has some new features which are of particular interest. In Fig. 1 is shown the outfit complete. The semaphore proper is of standard make and can be furnished in either the upper or lower quadrant types, as desired. A three spectacle casting is provided. The semaphore, selector and telephone equipment are all mounted on the same iron post, and the apparatus is self-contained. The weatherproof box is locked, so that access is obtainable to it only by means of keys which would be furnished to the proper parties. The semaphore blade itself can be furnished of any type or shape desired to conform to the practice of the railroad buying the equipment.

Everything is arranged for facilitating maintenance work. Ample size terminals are used throughout in the apparatus, and practically all maintenance connections inside the casting are made with terminal screws or hexagonal lock-nuts. The wiring throughout is of copper insulated weatherproof braided wire, in conformance with good signal practice. All the telephone apparatus is water-proofed to withstand moisture. All wood used in the interior of the set is oil treated. The telephone and selector are enclosed in an inner compartment. All openings are arranged so that water cannot enter the set. In addition, the outer door of the set has a weather-proof gasket, rendering it practically impervious to moisture.

Fig. 2 shows the pole casting containing signal mechanism, the telephone and selector equipment. The signal mechanism is of the electrically operated type, but is manually restored. The relay operating this is normally de-energized, and ten dry cells are required for its operation. As this relay will operate on four cells, it is obvious that an ample margin of operation is allowed.

The signal mechanism proper is contained in the compartment at the top of the casting. The only part of this which appears on the surface of the inside door is the handle

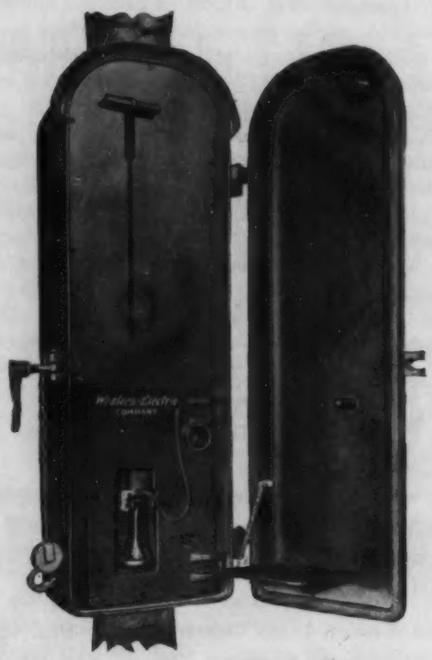


Fig. 2. Outer Door Open.

of the restoring lever. The selector and terminals are readily accessible for maintenace purposes.

One important feature of the selectively operated semaphore is the fact that it gives to the dispatcher an answer

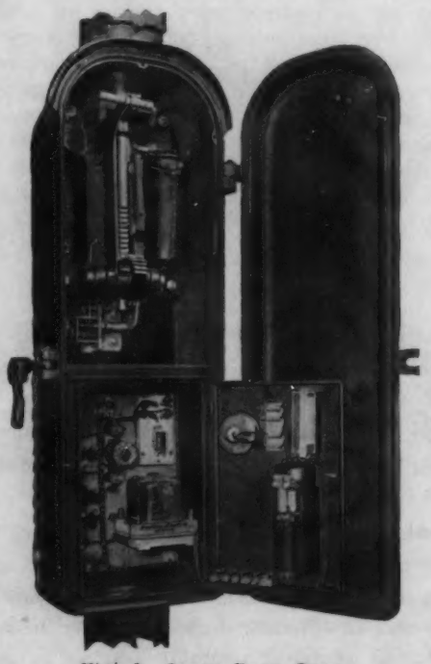


Fig. 3. Inner Door Open.

back which cannot be mistaken, telling him that one particular semaphore has completed its movement and is at the "stop" position at the time the answer-back is received.

The telephone set is especially designed for railway work, and is of high efficiency. The transmitter and receiver are mounted on the outside of the inner door, on the lower part of the apparatus casting. The transmitter mouthpiece is of metal and so fastened in the set that it cannot be removed without opening the inner door. All parts are arranged so that they can be easily inspected and maintained, and they are of the usual "Bell" grade quality. All metal is given a black finish, which eliminates any chance of rusting.

The signal mechanism is operated by the Western Electric's latest development in railway selectors. This selector is practically independent of weather conditions and absolutely reliable. It is in operation at the present time on eighteen of the largest railroad systems in this country, where it is giving universal satisfaction.

Fig. 3 shows the apparatus casting with the inside cover open. In this illustration will be seen the arrangement of the selector and terminal apparatus on the inside of the casting. The signal mechanism as shown above, together with the manually operated lever and the gears by means of which the semaphore blade is restored to the "Clear" position. The outside door of the apparatus casting is provided with a sheet iron writing shelf which will be a great convenience in taking down orders from the dispatcher.

The circuit arrangements of the signaling equipment above described are very similar to the standard train dispatching circuit. The dispatcher operates selector keys in the same manner; instead, however, of a bell ringing at the point called, a semaphore blade moves to "Stop." The answer-back signal returns to the dispatcher clearly and distinctly and then it waits for the crew of the train so signaled to call in. Should he be disconnected from the circuit for any reason the crew can easily call him, but ordinarily operating practice does not require this. Only one pair of wires are needed to extend along the line. As many sets as may be desired can be connected to this circuit, and it is used both for talking and signaling. All equipment is bridged directly across the circuit, and any piece of apparatus can be taken off the line without affecting the rest of the equipment.

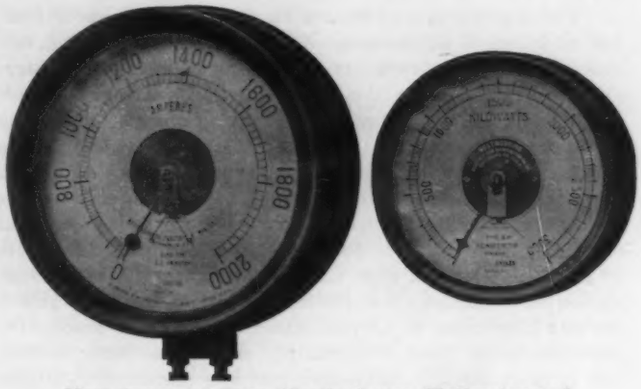
The use of these instruments affords an exceedingly flexible system, for as many semaphores can be located upon one telephone circuit as necessary, in addition to the telephone apparatus.

If desired, standard telephone apparatus can also be used at other points along this circuit where semaphores are not located. This semaphore equipment can also be placed upon existing train wires which are being operated by means of the telephone. In addition to being exceedingly flexible, the use of these semaphores insures an accurate, speedy, convenient and economical method of handling train movements.

NEW TYPES OF SWITCHBOARD METERS.

The increasing size of modern power developments and the growing capacity of available space, particularly in large cities, have emphasized the need of compactness in switchboard design. The desirability of having all the meters in plain view of one operator has long been appreciated, and this requirement necessitates meters that shall occupy a minimum of space and at the same time be easily readable from a distance. In many plants in congested districts the switchboard is located in a poorly lighted place, which imposes the further requirement that the meter dials be capable of thorough illumination. Accuracy and the possibility of making repairs quickly and easily on the premises are features that every power plant manager requires.

In line with these strongly defined tendencies in switchboard design, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has developed a design of alternating current and direct current switchboard instruments, which, for their novel features, are of extreme interest. The new meters comprise a complete line of seven-inch meters and a complete line of nine-inch meters. The seven-inch alternating current meters, known as the type SM, and the nine-inch, known as type TM, are built as ammeters, voltmeters, wattmeters, power factor meters, frequency meters and synchroscopes. The corresponding types SL and TL direct current meters are built as ammeters and voltmeters. The completeness of these lines make it possible to design an entire switchboard with one uniform type of meter, either seven-inch or nine-inch throughout.



Most Improved Type Westinghouse Wattmeter and Ammeter.

The scales of both sizes of alternating current meters are 14½ inches long. This remarkable scale length is as great as that found usually only in large illuminated dial meters, and greater than that obtainable with edgewise meters that occupy as much room on the switchboard as these seven-inch meters do. The great economy of space in comparison with the length of scale is shown in the following tabulation:

7-inch Type SM covers a rectangle 55 sq. in.; scale 14½ in. long.

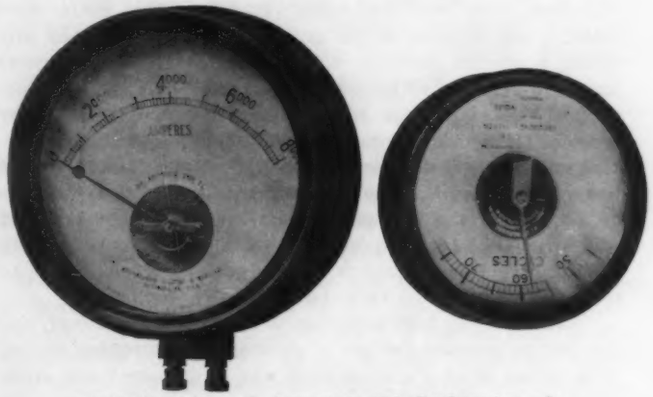
9-inch Type TM covers a rectangle 107 sq. in.; scale 14½ in. long.

Ordinary 9-inch meter round pattern, 107 sq. in.; scale 7¼ in. long.

Vertical edgewise meter covers 55 to 80 sq. in.; scale 12 in. long.

Horizontal edgewise meter covers 52 sq. in.; scale 6 in. long.

This long scale feature is not depended on alone to make the meters easily readable. Instead of the usual metal front,



Latest Design of Ammeter and Cyclemeter of Westinghouse Co.

a flat glass front is used. This makes it possible to thoroughly illuminate the dial from the front without the troublesome reflections often encountered with the curved covers of the edgewise types of meters, and enables the whole pointer to be seen, thereby making it possible to take accurate readings from a distance and from any angle.

These features of compactness and readability of the new 7-inch meters, combined with the perfectly damped indications and important improvements in the electrical design, mark a distinct advance in switchboard meter practice. The type TM 9-inch meters embody the same improvements and meet the demand for a larger meter where economy of space is not a prime consideration.

These meters have no moving coils or connections, as they operate on the induction principle; a rotating magnetic field, produced by current in stationary windings, acts on a light metal drum.

The construction of meters on this principle has a number of inherent advantages. The absence of a moving coil makes the use of flexible or sliding conductors unnecessary, and greatly simplifies the construction so that repairs are easily made. The lightness of the moving element makes the likelihood of damage to the pivot jewels remote, and reduce jewel wear to an inappreciable minimum. It is well known how seriously the proximity of heavy bus bars affects moving coil and moving iron instruments, even when special internal shields or iron cases are provided. Freedom from the effects of external field, and high torque, are among the advantages gained by utilizing the induction principle. This principle has now come to be recognized as the most practicable principle in the case of alternating current watthour meters, and it is reasonable to assume that the perfected induction indicating instruments will in time replace all other types for switchboard service, as completely as the induction watthour meters have replaced all other types, and for the same reasons.

A remarkable feature of the meters is the perfectly damped character of the readings. The pointer does not overshoot, even with full scale variation. This remarkable result is not obtained at the expense of accuracy, but by providing a special damping disk moving in the concentrated magnetic field of two permanent magnets. This "superdamping" of the indications will be particularly appreciated by those using meters on circuits or generators operating in parallel, where there is likely to be a rhythmic interchange of power, or pumping. The damping required to prevent wide oscillations of the pointer on such service can be obtained only by means of permanent magnet dampers. Compared with air dampers this method is not only more efficient, but so rugged in construction as to be practically "foolproof."

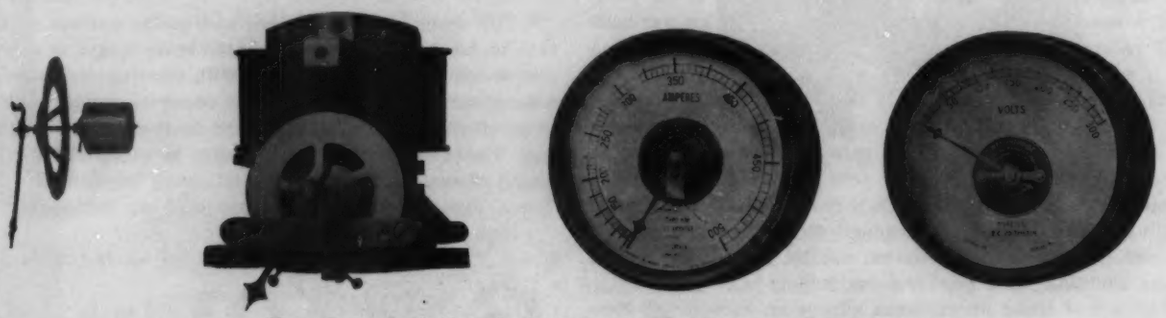
Exceptionally high torque is developed in the meter, and this makes possible the use of substantial controlling spring. This spring is of a special alloy and is tempered and artificially aged to insure permanence under all conditions. Extremely simple zero and calibrating adjustments are provided.

Extremes in weight have been avoided in these instruments. Wherever the principle of operation permitted, the weight has been made as small as possible consistent with substantial and serviceable construction. To this end the movement is made self-balancing to avoid the use of counterweights, the weight of the control spring is carried on the stationary support, all moving parts except the shaft are of aluminum, and the pointer is an aluminum punching of U-cross-section. On the other hand, wherever weight is required for strength it is present. The result is a moving element heavy enough not to be delicate, yet light enough to cause no damage to the jewels during shipment and to cause no wear in use. The ratio of torque to weight is higher than has ever been obtained before in commercial measuring instruments. The meters are therefore highly sensitive and accurate without being delicate.

The fact that the meter element can be removed from the case as a unit, allows all parts to be inspected without changing the calibration. The parts can be very easily removed and replaced, and the absence of moving coil or flexible connections makes this possible without danger of damage.

In these meters the previous designs of Westinghouse indication meters have been thoroughly revised to eliminate the effects of temperature changes, either of the air or of the meters themselves, and inaccuracies due to variations in frequency. The frequency meters, power factor meters and synchroscopes are of the well-known Westinghouse types with the added improvements developed for the rest of these lines.

The Types SL and TL direct current meters, supplement the line of alternating current meters and match them very closely in appearance. They have glass covers, the same types of cases and similar dial appearance, with scales 8 inches long. In fact the scales of the seven-inch meters are as long or longer than those found in previous makes of 9-inch meters.



New Type Switchboard Instruments Westinghouse Company.

The meters operate on the D'Arsonval principle, a moving coil and fixed permanent magnets, which avoids all residual error. They differ, however, from most meters employing this principle in having only one gap in the magnetic circuit. The moving coil is pivoted at one edge, encloses a circular pole piece, and the other moves through the air gap. With this construction the moving element can be removed and replaced without disturbing the magnetic circuit, and the entire magnetic circuit is magnetized, "aged" and tested as a unit, thus preventing any variation in the strength. The shape of the permanent magnets is such as to shield the meter from external magnetic fields and make it free from effects from nearby conductors.

The moving coil is mounted on a light metal frame, the motion of which in the air gap of the magnets produces a damping effect that makes the readings practically dead beat. As the coil is pivoted at one edge, its weight counterbalances that of the pointer; resulting in a naturally balanced moving element. This leads to long life of pivot jewels and accuracy of reading. The meters have exceptionally high full load torque.

The dials of all the meters here described are hand calibrated on white cards, thus insuring extremely accurate scales. The divisions are clear and open and the figures large and distinct.

NEWS NOTES

FINANCIAL.

ALBANY, ORE.—Albert E. Wright, of Portland, has been granted a 25-year gas franchise in this city.

LEAVENWORTH, WASH.—The Washington Steel and Iron Company has been granted a 10-year light franchise.

GOLDENDALE, WASH.—Samuel Hill, owner of power sites in the Klickitat gorge, above Lyle, will shortly sell his holdings to the Northwestern Electric Company for a consideration of $20,000.

OLYMPIA, WASH.—Bids will be received by the State Board of Control up to July 20th for one k.v.a. 2-phase 220-110-volt generator to engine. Specifications at office of Engineers Evans-Dickson Company, 725 Commerce street, Tacoma, Wash.

EUGENE, ORE.—A bond election will be held here July 17th for a $57,000 issue for power plant extensions and water works construction. Providing issue carries, the city will extend its power wires and engage in active competition with the Oregon Power Company.

REDDING, CAL.—A trust deed and chattel mortgage for $2,000,000 has been filed for record here by the Anglo California Trust Company, of San Francisco. The deed and mortgage are given by the Sacramento Valley Power Company, of Redding. The sum is to be drawn upon as money is needed to extend the power company's lines down the valley. Fleishhacker Bros. of San Francisco recently bought a controlling interest, and it is understood that the company is shaping itself to extend its lines to San Francisco.

SAN FRANCISCO, CAL.—The merger between the Great Western Power Company and the City Electric Company has been completed. The transaction took place in New York City, where the first payment of $800,000 was made to the New York representatives of Herbert and Mortimer Fleishhacker of this city. The balance of $3,200,000 is to be paid very shortly. Herbert and Mortimer Fleishhacker become vice-presidents of the Great Western Power Company and have the active management of the corporation while Edwin Hawley, the New York railroad magnate and multi-millionaire, becomes its president. The company now owns one of the largest and most valuable water rights in California. With the properties just acquired of the City Electric Company, the Great Western Company is generating by its water and steam power plants about 100,000 h.p. When its new dam at Big Meadows is completed, creating an artificial lake thirty miles in length, it will have a sufficient volume of water to ultimately generate an additional 300,000 h.p. It is estimated that the total amount invested by the Great Western Power Company and its subsidiary companies aggregates about $20,000,000.

INCORPORATIONS.

ENTERPRISE, ORE.—The Enterprise Electric Company has been incorporated for $50,000.

NEWPORT, ORE.—The Yaquina Electric Company, Newport, Ore., has been incorporated for $20,000.

FRESNO, CAL.—The Fresno, Coalinga & Monterey Railway, Fresno, Cal., has been incorporated for $4,000,000 at $50 per share; $200,000 subscribed.

BEAUMONT, CAL.—The El Caseo Water Company has been incorporated. The directors are: Henry Fuller, J. H. Fisher and Hoell Tyler, all of Redlands. The object of the company is to purchase, own, improve and develop land and water and to perform duties connected with water companies.

LOS ANGELES, CAL.—The West Ontario Water Company has been organized and incorporated in this city by a large number of citrus owners. They propose to develop extra water for irrigation of their groves by, R. B. Bell, Dr. Charles H. Ford and others.

ILLUMINATION.

VICTORIA, B. C.—The municipal council of Victoria has decided that it is necessary to extend and complete the system of lighting in the city of Victoria and that the sum of $50,000 required for the purpose be raised by bonding.

ELKO, NEV.—Sealed bids endorsed "Proposals for bids for furnishing and installing electric lighting fixtures for the new court house and jail, at Elko, Elko County, Nev.," according to plans and specifications of W. H. Weeks, architect, now on file in the clerk's office, at Elko, were received by Fred C. Voight, clerk of the Board of County Commissioners, up to July 12, 1911, when they were publicly opened and read. Result not announced.

SAN FRANCISCO, CAL.—Sidney Sprout has returned from Siskiyou County, where he is superintending the engineering work on the new 35,000 kw. hydroelectric installation of the Siskiyou Light & Power Company. Three generating units will be installed. The power site is on the Klamath River near Thrall. In addition to tieing in with the company's existing power transmission lines from the Fall Creek power station the new lines will be extended to Klamath Falls where the company recently purchased a local electric plant.

TRANSMISSION.

SALINAS, CAL.—A surveying crew has commenced work staking out the pole line of the Monterey County Gas & Electric Company down the Salinas Valley.

OROFINO, ORE.—Announcement has been made that an extensive power plant will be built on the North Fork of Orofino creek at the mouth of Whisky Creek.

PHOENIX, ARIZ.—The City Council has granted a franchise to the United States Reclamation Service to construct a power line through the corporate limits of Tempe. Irving C. Harris of Mesa represents the government.

PORTLAND, ORE.—Permission is sought by the Portland Railway, Light & Power Company, of the War Department, to construct a high tension electric power line across the Willamette River from the foot of Linn avenue, Sellwood, to a point south of Riverview Cemetery.

FALLON, NEV.—The U. S. Government is arranging to build a big electric plant at the new Lahonton dam for the purpose of supplying power for the operation of the gates and dams of the big Truckee-Carson project and also for the operation of big electrical pumps to drain the Carson Lake. The people of Fallon have circulated a petition to the government to have this work done at once and to sell power to the city of Fallon.

SAN BERNARDINO, CAL.—F. A. Worthley of Riverside will apply to the City Council for a franchise for an electric pole line covering this city. This is the initial move of the California-Nevada Power Company to get in Southern Cali-

fornia. Applications for franchises will be made to the Board of Supervisors of San Bernardino and Riverside Counties. Extensions are to be made throughout Southern California. Soon as franchises are secured the company proposes to begin development, expending $300,000 in San Bernardino and Riverside Counties.

PRATTVILLE, CAL.—It has been announced that the Great Western Power Company has acquired title from Mrs. A. E. K. Bidwell of Chico to 800 acres six miles north of here known as the Hamlin ranch, and that the property will be made a portion of a mammoth reservoir, part of the project for the construction of one of the largest power generating plants in the world. The purchase price is said to have been in the neighborhood of $30,000.

FRESNO, CAL.—Work is beginning on a substation of the San Joaquin Light & Power Company at a point ten miles west of Lemoore, which is designed to give more efficient service to Coalinga and the oil fields region. This substation, known as the Henrietta, will tap the Bakersfield loop when that line is finished, thus giving more direct connections for the Coalinga line, with fewer chances of interruptions in the supply of the current. This West Side loop is nearing completion rapidly now. Two crews are stringing the wire, working toward each other. One is opposite the western end of Tulare lake, while the other is two miles or so south of Summit Lake. A good deal of difficulty was found in the Summit lake region, with consequent delay, but this is now past and rapid headway is being made. There are about 25 miles to be covered to complete the loop.

TRANSPORTATION.

SALEM, ORE.—The Oregon Electric Railroad Company has started condemnation proceedings to secure a right-of-way through the city for an extension of the railroad.

SALEM, ORE.—The Oregon Electric Company has notified the State Railway Commission that it will comply with the regulations and install frogs and guard rails along its line.

SAN DIEGO, CAL.—The city clerk will receive sealed bids up to July 31 for the purchase of a franchise granting right to construct and operate an electric railway for a period ending September 1, 1952.

WATTS, CAL.—The city clerk will receive sealed bids up to August 8, 1911, for a franchise for a period of 50 years, to maintain and operate a railroad with two or more tracks, along certain streets of the city, to be operated with electricity.

WENATCHEE, WASH.—E. J. Felt, electric railway promoter of Tacoma, Wash., is here in interests of the Wenatchee Valley Railway and Power Company, and will shortly endeavor to secure a franchise for a street railway between this place and Leavenworth.

CHICO, CAL.—The Northern Electric Railway Company, through Assistant Secretary George Springer, has presented a petition to the Board of City Trustees for a franchise to construct and operate an electric line along Ninth avenue from the eastern boundary of the city to the western.

OAKLAND, CAL.—One of the most important matters disposed of at the final meeting of the City Council was the granting of the Oakland Traction franchise on East Sixteenth street from Thirteenth avenue to Elmhurst, for the purpose of establishing an "express" service between Oakland and Haywards.

SAN JOSE, CAL.—At the meeting of the Mayor and Common Council, petitions for franchises for electric standard-gauge railroads were received from the San Jose and Santa Clara County Railroad Company and from the San Jose railroads through their general manager, F. E. Chapin, on the Alameda, on Willow street, on Delmas avenue, and San Fernando and Cahill streets.

OAKLAND, CAL.—Ties are being laid on the 19th avenue street car line running from East Fourteenth street to the foothills to what is known as the Toler Heights tract, a distance of about a mile and a half. The preliminary work was started about a week ago, and within two or three months, the Oakland Traction Company expects to have a 20-minute service in operation.

WOODLAND, CAL.—The City Trustees, at their last meeting, granted the Vallejo & Northern Railway, a franchise on Main street from the eastern to the western limits. President T. T. C. Gregory, who was present, stated that the company's projected railroad between Woodland and Sacramento had been completely financed and that work on it will be commenced within sixty days. It will, he said, be completed and ready for traffic next spring.

SAN JOSE, CAL.—Five extensions of franchises to the Peninsula electric railroad, an allied corporation of the Southern Pacific, to build roads in various parts of Santa Clara County were granted by the Supervisors here yesterday. The franchises cover about 12 miles of road, and extend through a thickly populated district. It was announced that the new franchises are in line with the effort of the Southern Pacific to obtain a net-work of electric lines along the peninsula from San Francisco to San Jose.

REDWOOD CITY, CAL.—The City Trustees have granted a franchise to Edward S. Fitzpatrick, a Southern Pacific attorney for an electric line from Redwood City to Woodside, a distance of about six miles. Fitzpatrick says he is representing private individuals and that the Southern Pacific is not interested in the new line. It is believed here that Fitzpatrick is appearing for the Peninsula Railroad Company, and that it is the intention to connect San Francisco and San Jose by trolley.

STOCKTON, CAL.—Stockton is to have an electric railway to Byron, and if the plans do not miscarry trains will be in operation within 18 months. It is the intention of the company to ultimately extend the line to Antioch and Oakland. The parent company will file articles of incorporation within the next few days, and it will be capitalized at $1,000,000. The plans of this company are contingent upon future developments, but the line to Byron has been definitely decided upon. It will be constructed by an auxiliary company capitalized at $750,000, and known as the Stockton and Bay City Short Line.

SAN FRANCISCO, CAL.—The United Railroads of San Francisco have recently converted their Mason and Washington power station from steam to electric drive, so that all their cable lines are now motor driven. The Castro and Pacific avenue stations are operated with d.c. motors, while at Mason and Washington station the new installation is all a.c. apparatus. The speed of all cables has been increased about 3 per cent, and owing to the practically constant speed of the motor the cables travel at a much more uniform speed now than with the old equipment, it being impossible to control the steam engines with less than 5 per cent. The equipment has been installed by W. T. Bivins, chief engineer of electrical equipment.

OAKLAND, CAL.—The Oakland Traction Company has ordered 60 double-end, pre-payment type, arched roof cars for city service. These cars are 48 ft. long, over bumpers, with body 35 ft. 2 in. long; width over all, 9 ft. ¼ in.; width inside, 8 ft. 5 in.; platforms, 6 ft. 5 in. The seating capacity is 48 and longitudinal, slat seats will be used. The underframing of these cars consist of 8-in. steel channel side sills and yellow

pine center sills. The bumpers are 8-in. channel iron. Each car is equipped with two Brill maximum traction trucks having wheels of 33-in. and 21-in. diameter; wheel base, 4 ft. 8 in.; and axles of 5-in. and 3-in. diameter. Split motor gears are employed and the gear ratio is 16-71. Each car is equipped with two G. E. motors and two K-36-F controllers. G. E. straight air and St. Louis vertical wheel brakes are used. The special equipment includes the following: U. S. standard trolley stand, Curtain Supply Company's ring fixtures and K-Pantasote curtains, four "Star" ventilators in the closed compartment, pneumatic sanders, Eclipse style "C" fenders, G. E. gears and pinions, Brill journal boxes, and malleable cups for link and pin couplers.

TELEPHONES.

PLUMMER, IDAHO.—C. G. Mead has been granted a franchise to install a local and long-distance telephone system. Mr. Mead is connected with the Interstate Consolidated Telephone Co.. Work to start at once.

SOUTH BEND, WASH.—The United States Government will install a telephone line from the lighthouse at North Cove to this place, a distance of about 15 miles. The city has granted all concessions for the project.

TACOMA, WASH.—A contract for the Sunset Telephone and Telegraph Company's new sub-station at North Twenty-seventh and Proctor streets has been awarded, at $25,000, to Westerfield & Van Buskirk, 4111 North Thirty-sixth street. Orders have been given to rush plans for proposed sub-station for South Bend. John Schlarb, general manager, 1101 South E street.

WATERWORKS.

HOLTVILLE, CAL.—The Waterworks bond issue recently voted on was carried by a large majority.

JACKSONVILLE, CAL.—Work on the new gravity water system for Jacksonville will be resumed at once.

LONG BEACH, CAL.—$850,000 bonds for the purchase by the city of two private water plants was carried by a large majority.

BAKERSFIELD, CAL.—The Electric Water Co. will put in a plant in East Bakersfield capable of supplying that part of the city with water.

CULVER, ORE.—The final survey to locate the reservoir site and pipe line has been progressing for some weeks and is now about complete.

TACOMA, WASH.—The Council has passed an ordinance providing for the construction of 6 in. and 8 in. wooden water mains in Local Improvement District No. 574 in Tacoma.

STOCKTON, CAL.—Planning eventually to install a new substation for water supply in the southwestern part of the city the Pacific Gas & Electric Company purchased an entire block of land bounded by Center, El Dorado, Jackson and Clay streets.

OAKLAND, CAL.—Immediate extension of the pipe distribution system of the Union or Bay Cities Water Company was promised last week by representatives of the concern at a meeting of the Hopkins Street Improvement Club. This means that within 30 days work will be begun in the laying of the pipe system from its present terminal at Sixty-ninth avenue to the shores of Lake Merritt. When this is completed, one-third of the city will have been covered by the company. The work of piping the city of Alameda will be begun at the same time. A large force of men will be put at work in both cities and the work will be rushed to completion. Col. M. M. Ogden, contract manager, appeared as the company's representative at the improvement club last evening.

HERMISTON, ORE.—Preliminary work will start in the near future on a waterworks system estimated to cost $20,000. Deep wells are to be the source of supply and a reservoir will be constructed on top of Hermiston Butte, 140 feet above the city.

WALNUT CREEK, CAL.—Announcement of the formation of a company for the distribution of water in Walnut Creek and adjacent territory was made by Judge A. S. Ormsby, president of the San Ramon Valley Chamber of Commerce, at a meeting of the Walnut Creek Improvement Club. An unlimited supply of water has been obtained.

ALBUQUERQUE, N. M.—The Town Clerk is receiving sealed bids for the construction of a waterworks system, consisting of pumping plant, 300 gallons per minute, against 350 ft. head, and curb intake, 8 miles of water mains, from two to ten inches in diameter, 150,000 gallon steel tank and tower, concrete reservoir.

TAFT, CAL.—Officials of the Western Water Company were in Taft last week completing arrangements to establish a larger plant in the western part of town for the purpose of assisting in boosting the water to 25 hill and Fellows. A steam plant of 125 h.p. will be installed there while at the other end of the line two 250 h.p. gasoline engines will be used.

PARRAL, N. M.—The Conchos dam, situated several miles from the town of Santa Rosalia, will be finished by June, 1913. The reservoir will be 30 miles long and from five to six miles wide and will have a storage capacity of 66,000,000,000 cu. ft. of water. Conchos River will be used as the main canal of the irrigation system, from it ditches will lead in all directions in territory to be irrigated. J. G. McNab of Mexico City has charge of work.

REDWOOD CITY, CAL.—In view of a possible water famine in San Mateo County, the Supervisors Monday directed District Attorney Swart to make a report in the matter of water rights. The county, through the Spring Valley Water Company, supplies San Francisco with 8,000,000 gallons of water daily. Many sections of the peninsula are now unable to get water, and the county fathers believe that local residents should be supplied first.

BAKERSFIELD, CAL.—Contracts for machinery and pipe aggregating $160,000 have been let by the Western Water Company for the construction of the water line from the west end of Cole's levee into the West Side fields. Deliveries are guaranteed in 20 days. Bids for excavating, hauling and laying of the pipe are now being advertised for and the contracts will be let within a few days. Before another month passes it is expected that actual construction work will be begun. The company has drilled three wells at its main station at the west end of Cole's levee and three more will be drilled. The wells are drilled in a pit and the pump then set over them. After the surface water is pumped out the wells have flowed over the top of the casing four feet higher than the level of the lake, indicating that the source of supply has no connection with the lake. Analysis of the water proves it to be even purer than that used in Bakersfield. The supply is abundant and sufficient for the needs of the West Side. Two 250 h.p. pumping plants will be erected at this point and a 12-inch line will be laid to Moron, where another station will be erected and a pumping plant installed to raise the water to two 55,000 barrel tanks on Twenty-five hill from which storage the supply will be gravitated to Maricopa and pumped to the north end of the Midway field. Agents of the company have been securing contracts with good results and practically all of the capacity of the line, 40,000 barrels for the present, has been sold. The company is incoroprated for $200,000 and all the capitalization has been subscribed. The officers and directors are C. B. Colby, president; Fred H. Hall, vice-president; Ira Hockheimer, secretary, and T. M. Young and Walter Fisher, all of Bakersfield.

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